Wisconsin Water Quality Report to Congress

2000

Department of Natural Resources Wisconsin

Bureau of Watershed Management

PUB-WT-254-2000

Acknowledgements

This report was prepared through the coordinated efforts of many people who provided extensive information and assistance.

Author/Editor

Ron Martin

Contributors

Jim Amrhein, Jim Baumann, Tom Bauman, Tom Bernthal, Jeff Bode, Marsha Burzynski, Tom Burzynski, Laura Chern, Bill Fitzpatrick, Kari Fleming, Steve Galarneau, Vicky Harris, Lisa Helmuth, Jeff Helmuth, Steve Jaeger, Tom Janisch, Jim Killian, Doug Knauer, Jeff Kreider, Jim Kreitlow, Nancy Larson, Chuck Ledin, Mike Lemcke, Lee Liebenstein, Terry Lohr, John Lyons, Dave O'Malley, Mike Miller, Pam Packer, Karen Plass, Bob Ramharter, Tom Reardon, Eric Rortvedt, Jim Ruppel, Mary Ryan, Carroll Schaal, Karl Scheidegger, Duane Schuettpelz, Greg Searle, John Sullivan, Linda Talbot, Mike Talbot, Pat Trochell, Jim Vennie, Will Wawrzyn, Bob Weber, Richard Wedepohl

Photos

Wisconsin Dept. of Natural Resources files

Design/Layout

Georgine Price

Introduction

Wisconsin is a state rich in water resources. There are more than 32,000 miles of perennial rivers and streams and approximately 23,000 miles of intermittent rivers and streams for a total of about 55,000 miles. The state has 15,057 inland lakes (about 944,000 acres) of which 6,040 are named and 9,017 are unnamed. Wisconsin also has 1,751 square miles of Great Lakes' estuaries and bays that adjoin 1,017 miles of Lake Michigan and Lake Superior shoreline, 5.3 million acres of wetlands and two quadrillion gallons of groundwater. The task of assessing, monitoring and managing these water resources is staggering, and quite frequently, the data available on many of the water resources is outdated or non-existent.

Table of Contents

Executive Summary

This report is a summary document of all the water program activities for the Wisconsin Department of Natural Resources (WDNR). It meets Wisconsin's requirements of Section 305(b) of the federal Clean Water Act to report to Congress on progress in meeting and maintaining the goals of fishable and swimmable waters. Some of the highlights of this report are summarized below:

- Reorganization of the WDNR has resulted in a shift towards watershed management at the local level. This approach to management involves integrated planning for both water and land resources and public participation and partnerships that promote better resource protection.
- The Nonpoint Source program is undergoing a major restructuring aimed at improving water quality through more controls on agricultural runoff and urban nonpoint sources.
- To better assess ecosystem health and water quality impacts, the WDNR is shifting from more conventional water chemistry data collection efforts to relying more on biological monitoring using macroinvertebrates and fish.
- Over the last several years, the WDNR has ordered the removal of a number of dams on streams and rivers because of safety issues related to the age and condition of the structures. Subsequent monitoring data have shown significant improvements in water quality, aquatic habitat and species diversity as a result of removing the dams.
- The WDNR has initiated a new rivers strategy in 1999. Through a more coordinated approach to river management, the strategy is aimed at protecting and restoring riverine ecosystem integrity and balancing river resource uses with environmental needs.
- Monitoring data on the Mississippi River has shown an improvement in the water quality due in a large part to cleanup of point source discharges.
- The WDNR participated in the development of the Lakewide Management Plans (LaMPs) for Lakes Michigan and Superior. Projects have been identified by the WDNR that will help restore and protect the beneficial uses of the Great Lakes' ecosystem once they are implemented.
- New fish consumption advisories were put in place by the WDNR for PCBs starting in 1997. As a result, graduated advisories have been issued for fish with concentrations of < 2 ppm of PCBs to increase public understanding of what levels are safe for consumption.

- A number of contaminated sediment sites have been cleaned up over the last four years and cleanup of more contaminated sites are underway. These efforts have resulted in enhancement of the quality of Wisconsin's surface waters and reduction in public health and environmental risks.
- The WDNR is in the process of combining all classified waters into one administrative code (NR 104) and having those waters available on the Geographic Information System (GIS).
- The Wastewater Management program is creating a new informational database called System for Wastewater Applications, Monitoring and Permits (SWAMP) that will modernize the existing system for WPDES permits.
- Innovative approaches to management, such as watershed-based trading, are being evaluated as additional tools to improve water quality. Such trading shifts in pollutant-loading responsibility can result in more equitable, efficient, and cost-effective ways to address water quality problems.
- Future electronic updates of the tables for the 305b report will be easier because of WDNR efforts to verify and update the data in U.S. Environmental Protection Agency (EPA) Waterbody System. For this reporting cycle, the WDNR will provide U.S. EPA with an electronic update and hard copy insert of the tables for this narrative report as soon as it is completed, but no later than April 1, 2001.
- Lake management in Wisconsin has been greatly enhanced in the 1990s by the Lake Planning and Protection Grants. These grants have been used for land acquisition, wetland restoration, watershed best management practices and feasibility studies that aid in protecting water quality and improving aquatic habitat.
- With new state funding in the 1999-01 budget, the WDNR has increased information and education efforts to help control the spread of Eurasian watermilfoil, zebra mussels and other harmful aquatic nuisance species. New signage at boat landings, public service announcements and aquatic nuisance displays are all examples of efforts to increase boaters' awareness of the problem and solutions.
- Permitted wetland losses have dropped significantly as a result of implementation of wetland standards in NR 103 and the adoption of county shoreland protection ordinances.
- The WDNR has implemented the Source Water Assessment Program (SWAP) as required in the 1996 amendments to the Safe Drinking Water Act. The implementation of SWAP will protect public health by helping prevent contamination of public water supplies and assuring an abundant supply of clean water.

Recommendations

Many of the specific needs for action could be most effectively addressed through a reauthorization of the Clean Water Act. This would also be the most effective approach for resolving the needs, which are currently identified through the Gap Analysis. The Gap Analysis is defined as the difference between currently available staffing and fiscal resources and the staffing and fiscal resources necessary to manage and implement state water quality programs in a way that would achieve the environmental and public health goals contained in the Clean Water Act. The recommendations are summarized below.

Congress should complete reauthorization of the Clean Water Act by September 2001 incorporating the following issues:

- U.S. EPA should establish a schedule for the finalization of national nutrient criteria guidance.
- U.S. EPA should establish a schedule for the completion of national guidance for sediment quality criteria.
- U.S. EPA should develop watershed management program guidance, which requires sources regulated by the Toxic Substances Control Act (TSCA); the Resource Conservation and Recovery Act (RCRA); the Clean Air Act or the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA) to be integrated in accordance with water program requirements. Include the concept of best environmental management by allowing the state director to waive specific requirements or individual categorical requirements related to specific source controls. The objective is to implement integrated solutions that would cause the improvement of water quality through installation, or use of, best or most feasible technologies.
- U.S. EPA should develop consistent national goals for attainment of water quality standards through Total Maximum Daily Loads (TMDLs) or other watershed implementation strategies.
- U.S. EPA should establish national water resource monitoring programs to ensure that consistent and timely data are available to assess the condition of the nation's waters including protocols for sampling and analysis.
- The U.S. Congress should establish base appropriations to fund state obligations created by the federal commitments in the Boundary Waters Treaty with Canada and the associated Water Quality Agreement. This includes both staffing and project implementation funds to address the restoration of use impairments identified in both remedial action plans and lakewide management plans.
- U.S. EPA should increase funding for local 604(b) related water quality planning efforts.
- U.S. EPA should develop technical guidance and resources to support management decisions related to wetland and riparian zone protection and management.
- U.S. EPA should develop lake protection and management programs supported by technical research, technology transfer activities and resources for implementation funding.
- U.S. EPA should incorporate water resource needs as the basis for national and international efforts to reduce atmospheric toxicant transport and deposition.

The Coast Guard should establish clear and concise biological standards for the discharge of ballast water that is 99-100% effective (the goal is zero discharge) in preventing the introduction of new invasive aquatic species. In conjunction with development of a standard, a short-term plan should be developed to address the problem of NOBOBs (No Ballast On Board). An implementation schedule should be set to achieve the new technology in a series of steps for both new and existing ships. Subsequently, the standards and the implementation schedule should be incorporated into the reauthorization of the National Invasive Species Act.

Protection of Wisconsin Surface Waters

Wisconsin protects and manages its vast water resources for the benefit of its more than five million citizens and its many visitors and to maintain a diverse aquatic ecosystem. The state has set "water quality standards" for all state surface waters. The standards (or levels of protection) for a waterbody will vary depending on its classification. The highest levels of protection are afforded Outstanding and Exceptional Resource Waters.

The antidegradation policy, contained in NR 207 of the Wisconsin Administrative Code, is one of the cornerstones of the protection program for Wisconsin's surface waters. The antidegradation rules that took effect in March 1989, have provided additional protection from point source discharges for surface waters classified as Outstanding Resource Waters (ORWs), Exceptional Resource Waters (ERWs) and fish and aquatic life.

For ORWs, any wastewater discharge must be treated to a very high level under the antidegradation rules, at least as high as the quality of the receiving water. The same requirements are generally true for Exceptional Resource Waters. The exceptions include: 1) existing dischargers that are grandfathered without new restrictions and 2) new discharges that are needed to correct situations where public health is at risk because of groundwater contamination.

The regulations in NR 207 also apply to waters that are classified as supporting fish and aquatic life. Any new or increased wastewater discharges from municipal or industrial sources to fish and aquatic life waters must meet more stringent effluent limits based on the antidegradation policy. The objective is not to allow any lowering of water quality as a result of new or increased discharges to these waters.

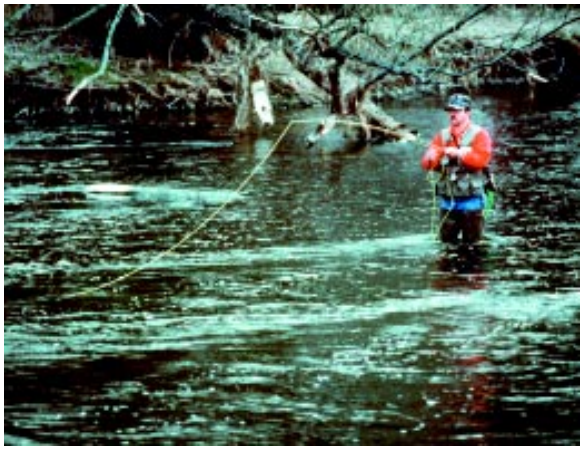
The application of water quality standards, and the antidegradation policy provide the bases for protection of Wisconsin's surface waters. However, there are many other innovative programs and activities that the WDNR is involved in that protect and enhance the quality of its surface waters. Some of these include: pollution prevention efforts, contaminated sediment cleanup, nonpoint source pollution abatement/cleanup, lake protection efforts, toxic substance control, wetland protection and preservation, dam relicensing and removal, stormwater control and invasive species management. All these efforts, and others, are important in providing resource protection and enhancement.

Summary of Classified Uses

All Wisconsin rivers and lakes are classified for the beneficial uses they are capable of supporting if controllable impacts to water quality are managed. The classification categories are found in Wisconsin Administrative Code NR 102. The use categories are fish and other aquatic life, outstanding resource waters, exceptional resource waters, recreational, public health and welfare, and wildlife.

Fish and other Aquatic Life Uses

Fish and other aquatic life uses are further classified in Wisconsin Administrative Code NR 102.04(3) in the following subcategories:



Trout fishing is a popular pastime on Wisconsin waters.

- Cold water communities: These are surface waters that are capable of supporting a community of cold water fish and other aquatic life or serving as a spawning area for cold water fish species and includes, but is not limited to, surface waters identified as trout waters (Wisconsin Trout Streams, publications 6-3600(80)).
- Warm water sport fish: These are surface waters capable of supporting a community of warm water sport fish or serving as a spawning area for warm water sport fish, such as bass.
- Warm water forage fish communities: These are surface waters capable of supporting an abundant, diverse community of forage fish and other aquatic life. All surface waters in the state not listed in Wisconsin Administrative Code NR 104 are, by default, classified as warm water forage fish communities.
- Limited-forage fish communities: These are surface waters capable of supporting only a limited community of forage fish and other aquatic life due to low flow, naturally poor water quality, or poor habitat.
- Limited aquatic life: These are surface waters of severely limited capacity due to very low or intermittent flow and naturally poor water quality or habitat, capable of supporting only a limited community of aquatic life.

Surface waters classified in the limited forage fishery or limited aquatic life subcategories are not capable of achieving Clean Water Act goals. These waters are listed in Wisconsin Administrative Code NR 104.05 to 104.10.

Outstanding & Exceptional Resource Waters

Wisconsin has classified many of the state's highest quality waters as Outstanding Resource Waters (ORWs) or Exceptional Resource Waters (ERWs). Chapter NR 102 lists the ORWs and ERWs. The identification of ORWs was one of the requirements for federal approval of the antidegradation policy.

The WDNR conducted a statewide evaluation effort in the early 1990s to determine which waters qualified for ORW and ERW classification. By January 1993, through a highly public and controversial process, a significant number of waters were added to chapter NR 102 as ORWs and ERWs. At that time, only two flowages were included as ORWs because the WDNR did not have adequate information or a systematic approach for classifying flowages. Subsequently, at the direction of the Natural Resources Board, the agency conducted an extensive

ORWs and ERWs provide excellent recreational opportunities.

monitoring and evaluation program on eight flowages over a 3-year period from 1993-96. As a result of that effort, selection criteria were developed by the WDNR staff for flowages and approved by the Natural Resources Board. Four flowages were classified as ORWs using these criteria and added to the list of waters in NR 102 in January 1998. These flowages, all of which are located in northern Wisconsin, include the St. Croix Flowage in Douglas County, the Gile Flowage in Iron County, the Willow Flowage in Oneida County and Caldron Falls Flowage in Marinette County. The classification of these flowages corresponded with the state's purchase of 16,145 acres surrounding the Willow Flowage from the state's Stewardship Fund.

No additional waters have been classified as ORWs or ERWs since January 1998. Below is a summary of the number of waters that are classified in NR 102 as Outstanding and Exceptional Resource waters:

	ORWs	ERWs
Streams	220	1532
Lakes	97	
Flowages	6	

A total of 2,075 stream miles or 6.5% of the 32,010 perennial river miles in the state have been classified as ORW. A total of 3,661 stream miles or 12% of the river miles in the state have been classified as ERW. Of Wisconsin's 27,723 waterbodies, 1,855 (6.7%) are now classified in NR 102 as either Outstanding or Exceptional Resource Waters.

Recreational Use Waters

Surface waters in the fish and aquatic life use classifications may also be classified as recreational use waters. This classification assures standards protecting surface waters from fecal contamination. A bacterial examination of the water determines the suitability of a recreational use classification. As a result of this classification, municipal dischargers to recreational use waters may be required to disinfect their effluent.

Public Health and Welfare

All surface waters shall meet the human threshold and human cancer criteria specified in Wisconsin Administrative Code NR 105. The applicable criteria vary depending on whether the surface water is used for public drinking water supplies and the designated aquatic life use subcategory. All surface waters that provide public drinking water supplies or classified as cold water or warm water sport fish communities shall meet taste and odor criteria as specified in NR 102.

Wildlife

All surface waters shall be classified for wildlife uses and meet the wildlife criteria as specified in NR 105.

Ongoing and Future Use Designation Efforts

The WDNR currently has an effort underway to update the classification listings in NR 104. This effort is expected to be complete with effective rules in FY 2000.

The WDNR is also currently involved in a rule revision effort focusing on surface water use designation policies. The effort is being undertaken by a group known as the Water Body Use Designation (WBUD) Advisory Committee (AC). The WBUD effort will focus on seven issues. WDNR staff only will undertake two of these issues with the other five being dealt with by subgroups of the AC.

The two issues that will be completed by WDNR staff are compiling all classified waters into NR 104 (including the outstanding and exceptional waters that are presently in NR 102) and having all classified waters available on the Geographic Information System (GIS).

AC subgroups have been formed to deal with the following issues:

- Use Designation Guidance - New guidance is being drafted using current knowledge and science for designating fish and aquatic life uses for Wisconsin surface waters.
- Effluent channels/discharges to dry runs/ratcheting - Situations are being addressed where a discharger "creates" a continuous flowing surface water, and thereby habitat for aquatic life by virtue of the discharge location.
- Seasonal use/Great Lakes drinking waters designations - Issues are being addressed related to seasonally protecting species that may be present in surface waters during specific times of the year and determining drinking water designations with respect to Great Lakes tributaries.
- Wetlands - Wetland use designations and how to determine those use designations are being addressed.
- Implementation - It is being determined how the different approaches that are brought forward by the other four subgroups fit together into the implementation process.

Designated and Beneficial Use Support

For Clean Water Act reporting, the WDNR evaluates a waterbody by the ability to support its "designated" or "beneficial" uses. The designated use of a waterbody identifies the type of aquatic community the water should be able to support and the type of functions it is expected to provide. In all cases, water quality standards are set to protect the designated and beneficial uses, which are supported by the waterbody classification. There are different types of use supports including fish consumption, secondary contact recreation and fish and aquatic life.

A waterbody with a fish consumption advisory or with water conditions that no longer support the natural aquatic community would not fully support its designated use. In some cases the use designation is threatened or partially supporting, but in other cases it is not supporting. Determining whether the use is supported or not is the judgment of water quality biologists and resource managers. Assessments are particularly difficult when information on a waterbody is limiting or inconclusive.

Not all waters can achieve the "fishable, swimmable" goal set in the Clean Water Act. A variety of factors such as low or intermittent flow, poor water or sediment quality or degraded habitat can limit the use of a waterbody. The variety of physical or chemical conditions that limit a waterbody's use can be natural or human-caused. Limited-forage fish communities and limited aquatic life waters are two of Wisconsin's stream classifications that can not achieve the fishable, swimmable goal. These limited use waters are listed in NR 104 Wisconsin Administrative Code.

Environmental Issues & Concerns

There are a number of issues that are of particular concern to Wisconsin's aquatic environment that are summarized in this section.

Environmental Issues Related to Cranberry Production

With proper management practices, environmental impacts of cranberry cultivation can be reduced.

Cranberry cultivation is an important and growing industry in Wisconsin. As with any agricultural practice, environmental impacts can occur. Cranberry cultivation has the potential to impact surface water quality, alter water levels in lakes and streams, and cause the loss of wetlands. With the industry's intensive use of water and the application of fertilizers and pesticides in a wet environment, impacts to streams and lakes can be more direct than for other agricultural operations. The cranberry industry is working on best management practices and other methods to better protect surface waters and wetlands.

Authority for the WDNR to regulate cranberry operations is limited by exemptions in state laws. Because of a law adopted in 1867, commonly referred to as the "Cranberry Law," cranberry growers are exempt from having to obtain state permits for many of the activities that result in physical alterations to lakes and streams, including diverting irrigation water, ditching and the construction of dams.

Water Quality Concerns

Studies of several northern lakes located downstream from cranberry operations have shown increased levels of nutrients and phosphorus. The increased nutrients can cause excessive weed and algae growth and reduce dissolved oxygen in downstream surface waters.

Increased sediment loads to adjacent waters can occur during construction, ditch maintenance activities, and from eroding dikes, resulting in turbidity and sedimentation. Discharges of sediments to sensitive wetlands and trout streams are of particular concern.

There is the potential for pesticides applied to cranberry beds to be discharged to downstream surface waters or wetlands. Several studies have found pesticides in waters receiving cranberry bed discharges. Although these studies were conducted downstream of existing cranberry operations, no direct causal link has been established between the pesticides and the industry.

In response to the concerns about pesticide impacts, the cranberry industry has reduced the amount and frequency of their pesticide use through a program called Integrated Pest Management (IPM), reducing applications of pesticides by 25% in the last three years. Fifty-five percent of Wisconsin cranberry growers employ IPM programs. The industry is also researching the use of natural control agents as a means to address pest problems on crops.

Another water quality issue associated with cranberry cultivation is the potential for increased temperatures. Studies have found stream temperatures are elevated downstream of

cranberry reservoirs. The increased temperatures, especially if added to other factors resulting in habitat degradation, can adversely affect trout streams. To address this issue, the cranberry industry is working cooperatively with the WDNR to evaluate how the use of bottom-draw dams may help mitigate these adverse temperature impacts.

Water Quantity Impacts

Surface waters are the primary source for water used for irrigation, frost protection, winter flooding and harvest by the cranberry industry. In spring when water levels are generally high, cranberry operations discharge excess water into receiving waters. In summer drought and in the fall, cranberry beds are irrigated or flooded, reducing the amount of available water to nearby waters. The timing of diversions from, and discharges to waterways, can increase water level fluctuations in some waterbodies beyond what would normally occur. Diversion of water from a stream may temporarily reduce downstream flows, potentially resulting in increased temperatures and reducing suitable habitat for existing aquatic life. Increased use and storage of water in cranberry operations located upstream of managed wildlife areas may decrease water supplies to associated waterfowl impoundments.

As the demand for a limited water supply increase for various users, conflicts have also begun to rise. Cranberry growers have worked to improve water use efficiency through management and technological advances, especially with sprinkler systems. Some growers also recycle and reuse water.

The public and other industries have expressed concerns over reservoir management that cause flooding to adjacent properties. Since water diversion laws are not applicable to cranberry operations, dams are not regulated by the WDNR and cranberry growers work directly with neighbors to address these concerns. Creation of reservoirs often necessitates the construction of dams on natural steams. These dams may impede fish migration to spawning areas, thus reducing reproductive success of certain species of fish.

Wetland Impacts

Historically, wetlands were lost when cranberry beds, ditches, dikes and roads replaced natural sedge meadows, bogs and shrub and forested swamps. Cranberry beds in Wisconsin currently occupy approximately 15,000 acres of former wetlands. In addition, the industry has about 23,000 acres of reservoirs statewide, and much of this acreage is former wetlands. The wetland loss associated with the industry is a small percentage of the total historic loss. Wisconsin lost about 5.3 million acres of wetlands from all causes, including other forms of agriculture.

Cranberry cultivation accounts for a substantial portion of permitted wetland losses in recent decades. In a study of wetland losses and impacts authorized by the U.S. Army of Corps of Engineers, 97 individual permits were issued for wetland fills for cranberry operations from 1982 to 1989. This amounted to 4,986 acres of wetland impact. During that same time period, the total wetland loss authorized by all other individual permits was 9,247 acres. In 1991, Wisconsin established wetland rules that allowed for better protection of wetlands. This has resulted in a reduction of wetland losses from cranberry expansion and from other industries. Although the cranberry industry has continued to expand into wetlands, cranberry growers are increasingly avoiding wetland impacts. Much of the recent expansion has been into upland areas. Since the wetland rules were established, approximately 284 acres of wetland loss have been authorized for cranberry activities.

In addition to direct losses of wetlands, wetlands may be indirectly lost or degraded through hydrologic changes when cranberry growers ditch, dike and divert surface waters through wetlands. For example, much of the area flooded by reservoirs was wetland before it was flooded. Sedge meadow, floodplain forest, conifer swamp and conifer bog complexes

Wetlands provide important habitat for many wildlife species.

have been converted to open water marsh. Flooding of natural communities eliminates habitat and can result in species displacement or elimination. Since permits are not always required for reservoir construction, these indirect losses and impacts have not been quantified.

Although reservoirs may flood out important wetland community types, they may also create or enhance wetland and surface water habitat. Many reservoirs provide important habitat for fish, such as largemouth and smallmouth bass, northern pike and for wildlife species such as ducks, geese, herons, sandhill cranes, ospreys and bald eagles. Many cranberry growers encourage wildlife use of property by erecting wood duck nesting boxes and eagle, goose and cormorant nest platforms, installing fish aerators, planting food plots and harvesting timber to enhance wildlife habitat. However, because the primary purpose of the reservoir is to provide water for cranberry cultivation, water fluctuations can occur which may be harmful to aquatic and wildlife species.

Cranberry beds are intensively managed to support a single wetland plant species, which essentially eliminates the natural biodiversity of wetlands. No structural diversity and little cover are available for wildlife habitat. Wildlife species are discouraged from using cranberry beds. Studies of cranberry operations have generally shown little wildlife habitat remains in the intensively used beds, ditches, dikes and road areas. However, a substantial portion of "support lands" owned by cranberry operations is left relatively undisturbed, and continues to serve as important wildlife habitat.

Impacts Associated with Riparian Development

The addition of nutrients and sediments from near-shore developments to lakes can seriously impair water quality. Prevention of nutrient and sediments from reaching lakes is the rationale behind shoreline zoning regulations. The state, for example, requires a minimum setback from lakes for dwellings and has restrictions on cutting, grading and filling in the shoreline zone. Recently, some Wisconsin counties are requiring further restrictions and buffers between lakes and any developments. There are, however, very limited data to support the effectiveness of vegetative buffer zones on reducing nutrient and sediment loads to lakes. County zoning regulations and WDNR field staff need scientific support to respond to challenges and make reasonable decisions on the effectiveness of buffer stripes and zoning regulations.

Research studies were conducted at six sites during the fall of 1999 on lake front properties in Vilas and Forest Counties. The sites varied in their vegetative cover (forested versus lawn versus shrubs) between developed properties and the lake. Water samples from surface runoff and groundwater was collected during storm events for nutrients and sediments. The USGS and the WDNR are conducting the study.

Only samples from the fall 1999 runoff events have been analyzed thus far. Preliminary results suggest the forested buffer strips had a higher yield coefficient for nutrients than the lawns during the late fall runoff. The project will continue through the next two summers.

Mercury Contamination Issues

Mercury is a critical pollutant of concern in Wisconsin waters that is manifested as a problem in fish consumption advisories statewide and in the physiological impacts on birds that consume contaminated fish. The WDNR has invested major resources towards better defining the biogeochemistry of mercury in aquatic ecosystems.

One aspect of the ongoing mercury research effort is on the Lake Superior ecosystem. U.S. EPA, the National Science Foundation and the Wisconsin Sea Grant Institute are providing funding. Over the last several years, a team of scientists from the WDNR's Environmental Contaminants Section have monitored tributaries to Lake Superior in Minnesota, Wisconsin and Michigan for total and methyl mercury (soluble and particulate) in addition to other trace metals. Water samples were also collected for total and methyl mercury (soluble and particulate) in Chequamegon Bay, Wisconsin; Whitefish Bay, Michigan; the St. Louis River estuary in Minnesota and Wisconsin; and at 19 sites from the open waters of Lake Superior. There is an intensive effort to monitor mercury cycling through the Tahquamenon River watershed that drains to Whitefish Bay. The information collected is being used to construct a mercury cycling model for the Lake Superior ecosystem. The ultimate goal is to predict the changes in the mercury concentration of Lake Superior fish as the result of emission controls on mercury emitters within the lake's airshed.

A second mercury project involves developing a wildlife mercury risk assessment model using the common loon. A team of scientists is conducting both field and laboratory studies using a fish-eating bird to determine the physiological impact of consuming fish with different levels of mercury. The laboratory work is designed to use the common loon in a controlled setting versus the field studies, which involve other environmental variables. The product will be a pharmacological model that will produce the Lowest Observable Effect Level (LOEL) and the No Observable Effect Level (NOEL) for mercury consumption by the common loon. Because the actual dietary consumption of fish by the loons in the field is being monitored as a part of this study, a safe mercury level in fish for the protection of the common loon can be established.

Another project involves working on measurements of atmospheric mercury to northern Wisconsin, mercury-cycling through lake-bog connections, and potential changes in the mercury concentrations from young of the year fish captured in Little Rock Lake over the past decade.

On the last project, the WDNR is involved with the U.S. EPA on a mercury TMDL project at Devils Lake in Sauk County. Field efforts involve monitoring the mercury cycle in Devils Lake over a three-year period. These data are used to verify the U.S. EPA selected Mercury Cycling Model being used as a part of the TMDL.

Water Pollution Control

Wastewater Management

The WDNR regulates wastewater discharges through the WPDS permit program.

The Wisconsin Department of Natural Resources has primary state management authority over wastewater treatment and disposal in the state. This management responsibility is accomplished through the implementation of the following programs and activities:

- Wisconsin Pollutant Discharge Elimination System (WPDES) permits program.
- Industrial pretreatment for discharges to municipal sewerage systems.
- Approval of plans for wastewater treatment and disposal facilities and practices.
- Enforcement and compliance assistance activities.
- Assuring continuing and sufficient wastewater management practices in municipalities through a compliance maintenance program.

WPDES Permit Program

The WDNR regulates municipalities, industrial facilities and significant animal waste operations discharging to surface waters or groundwater of the State of Wisconsin through the Wisconsin Pollution Discharge Elimination System (WPDES) Permit Program. No person may legally discharge to surface waters or the groundwater of the state without a permit issued under this authority. All permits issued under the WPDES permit program are either specific permits or general permits. Specific permits are issued to individual facilities. General permits are issued statewide to cover facilities with similar discharges. The WDNR makes a determination on whether a particular facility is appropriately covered by a general or specific permit.

Permits issued under the WPDES Permit Program may contain the following:

- Effluent limitations for conventional and toxic substances in the discharge,
- Sludge (biosolids) and by-products solids disposal practices,
- Pretreatment requirements, where applicable,
- Compliance schedules for facility improvements, and/or
- Monitoring and reporting requirements.

The number and type of permittees currently regulated by the WPDES program are:

Municipal	663
Industrial	480
Animal waste	66

Permit Backlog

The WDNR is not, in all instances, able to reissue permits before the 5-year term expires. The number of expired permits, however, is a small fraction of the total number of WPDES permits that are issued in any given time.

The objective of the WPDES permit program is to maintain a backlog of less than 10%. As of January 1, 2000, the backlog of industrial and municipal permits was under the 10% goal. U.S.

EPA reported on January 1, that nationally, the percentage of expired major permits that they track was between 25 and 30 percent. Therefore, comparatively, by this measure, Wisconsin's program is much better than most other states or the U.S. EPA. Importantly, under Wisconsin law, any permit that has expired continues in effect until it is reissued or revoked. Facilities with an expired permit, therefore, are restricted in the amount of pollutants they can discharge as if the permit has not expired.

Permits have expired and have not been issued for several reasons:

- The WDNR is awaiting additional data from the permittee.
- Public or other comment necessitates additional review.
- New federal rules need to be adopted into state administrative code, a lengthy legal process.
- Significantly more complex regulations in the past several years (e.g., Great Lakes Water Quality Initiative, municipal biosolids, etc.) have created additional workload in implementation.
- Other state regulations need to be updated to respond to U.S. EPA objections and assure there is adequate authority to issue the permit with the conditions that will protect water quality.
- A permittee is in significant non-compliance and enforcement action is underway.
- WDNR is in the process of designing and bringing into operation a new computer system that requires training of staff writing permits.

The WDNR has also addressed the permit backlog issue through the creation of "Reduced Effort Permit" guidance for use by permitting staff throughout the state. This guidance allows WDNR staff to make judgments on the environmental significance of particular dischargers, and encourages a process to "shortcut" the administrative review and permit issuance time. Any permit that falls within the reduced effort category still undergoes all the public notice procedures, but the creation of some efficiency in the system has reduced the work effort of WDNR permitting staff.

General Permits

A general permit is designed to cover groups of facilities or industries with similar types of wastewater discharges to surface waters and/or groundwater. Currently, there are 18 general permits that may be used to cover applicable discharges. During 1999, the following five general permits were reissued by the WDNR:

- Concrete Products Operations
- Non-Metallic Mining Operations
- Asphalt Concrete Operations
- Outside Washing of Vehicles, Equipment and Other Objects
- Short Duration Discharges

There is no current statewide tracking system for facilities covered by the General Permits, but the number of facilities covered is in excess of a few thousand.

Data/Information Management

Within the past few years, the WDNR has expended considerable effort to develop a new information system for the WPDES program. This new system was necessitated by the new hardware and technology, by Y2K incompatibilities, and by an overall inefficient prior system. The creation of the System for Wastewater Applications, Monitoring and Permits (SWAMP) will modernize the WPDES system to assure the state has a system for the future. Primary features of the system are its ability to store much more monitoring information, more easily track compliance and create greater consistency in the drafting of permits. As of early 2000, many, but not all features of the system are in use. WDNR staff who implements the WPDES program will need to be fully trained to gain full use of the system.

Adjudication's Resolved

Permittees may legally appeal terms and conditions of a permit within a specified time following issuance. At the beginning of 1999, there were 34 outstanding adjudicatory requests pending resolution. By the end of the year the list of pending cases had been reduced to 21, mostly by modification or reissuance of a permit to include revised regulatory requirements. In one case, the circuit court upheld WDNR's position in the issuance of effluent limitations to a poultry raising and processing facility. A portion of this judgment is currently on appeal to a higher court.

Effluent Limitations

Each permit contains effluent limitations based on the type of facility or water quality based effluent limitations calculated to meet water quality standards. Effluent limitations may regulate the amount of biochemical oxygen demand, suspended solids, pH, phosphorus, ammonia, chlorine, other toxic substances, or other conditions depending on the type of facility and the water to which it is discharged. The need for whole effluent toxicity testing requirements is evaluated for all permits that discharge to surface waters. Further information on the results of toxicity testing of wastewater effluents is contained in this report under Ecosystem Health Assessment. Land application systems normally regulate the amount of nitrogen, chlorides or other materials that may contaminate the groundwater.

Chlorides Rule

In February 2000, the state adopted a unique rule to deal with the discharge of chlorides in wastewater effluents. This rule created acute and chronic aquatic life criteria within the water quality standards and an implementation rule for the WPDES permit program. Because end-of-pipe treatment to remove chlorides in many wastewaters (e.g., domestic sewage) is too expensive or technologically not feasible, the rule allows for the establishment of a case-by-case variance for discharges that are unable to meet the water quality based effluent limitations for chloride. As a condition of this variance, the permittee agrees to implement source reduction measures within the municipality or industry so that, over time, the amount of chloride in the discharge may be reduced to levels that meet standards. This rule addresses chlorides, a pollutant many other agencies have not addressed to this level of detail, in a practical and complete manner.

Cluster Rule for the Pulp and Paper Industry

Five pulp and paper mills in Wisconsin fall under the requirements of the "cluster rule", a rule intended, among other things, to limit the discharge of chlorinated compounds to surface waters. The effective date for compliance with the requirements of this federal regulation is in April 2001. WPDES permits for the five facilities were extended to that date to assure they have sufficient time to meet the requirements of the rule. Most of the facilities are already meeting the intent of the "cluster rule" by changing their manufacturing processes to chlorine-free operations.

Biosolids and Sludge Disposal

About 40 percent of the costs incurred to construct, operate and maintain a municipal wastewater treatment facility come from processing, handling and recycling the residues—the sludge or biosolids—that result from wastewater treatment. Most municipal and many industrial facilities in Wisconsin dispose of wastewater treatment sludge or biosolids through application on the land as a soil conditioner or fertilizer. More than 98 percent of municipal sludge, for example, is either applied on farmland as a soil conditioner and fertilizer, or distributed for individual use. Of 485 municipal facilities which dispose of sludge annually, 477 beneficially reuse it, two incinerate it, and six dispose of sludge in a licensed landfill.

There are an additional 200-permitted facilities which treat wastewater in lagoon systems and thus dispose of sludge periodically, but infrequently. These facilities almost universally land apply their sludge.

Regulations and permit conditions control the amount of sludge or biosolids that may be land-applied depending on the soil, slope, time of year, proximity to residences and wells and other factors. Application rates are limited to the agronomic needs of the crop to be grown and soil analyses are required at least every four years. Phosphorus levels in sludge have increased as Wisconsin has limited the amount of phosphorus that can be discharged directly to surface water in the effluent. Therefore, sludge must be managed in a way that will keep it on the land and minimize the potential for runoff to surface waters.

The state also regulates all septage pumped from 698,000 septic systems (300,000 of them on required maintenance schedules) and 30,000 holding tanks. Septage must either be taken to a wastewater treatment plant for further treatment or directly land-applied. The same site criteria apply to septage as to sludge.

Delegation of the Sludge Program

Wisconsin has applied for delegation of the sludge program under Sections 402 and 405 of the Clean Water Act. This application requires the WDNR to meet certain conditions acceptable under the federal program. Wisconsin's application indicates that the state program meets and exceeds all federal requirements for program implementation and oversight. By mid-2000, Wisconsin expects to become only the fourth state to receive delegation to administer the biosolids program.

Pretreatment

Pretreatment dischargers are industrial facilities that do not discharge their wastewater directly to the waters of the state, but instead discharge into a municipal sewerage treatment plant. The WDNR has been delegated the authority to administer this federal program. Twenty-six municipal governments in the state are responsible for meeting state and federal requirements for implementation of pretreatment requirements. These "control authorities" regulate discharges to their systems through the issuance of permits and other local controls. Industrial discharges that are subject to the pretreatment requirements of the state, but are not within the systems of these municipal control authorities, must obtain "permits" from the WDNR. There are a total of 165 facilities that the WDNR issues these latter control documents.

Enforcement and Compliance Assistance

The WDNR monitors permitted discharges to assure permittees are complying with the terms and conditions of their permits. This "compliance assurance process" takes several forms and includes:

- Compliance maintenance—working with and assisting facility owners and operators to remain compliant.
- Compliance assessment—conducting inspections of facilities and on-site assessments, review of discharge monitoring reports and other reports for compliance, follow-up on self-reported violations.
- Enforcement—formal actions taken when a significant violation is identified including notification of a violation of a permit condition, formal enforcement conferences and/or contacts and referral to the state Department of Justice (DOJ).

Permittees holding WPDES permits have an excellent record of compliance. It is estimated that permittees had a 97% rate of compliance with permits during 1999. The following information cites the number of cases of significant violations identified during 1999, along with the other formal enforcement data:

Incidents of significant noncompliance 223
Formal enforcement cases active during 1999 82
Stormwater enforcement cases active during 1999 26
Number of cases referred to DOJ 10
Number of stormwater cases referred to DOJ 6

Phosphorus Removal

In 1992, the WDNR adopted rules to require all larger point source dischargers in the state to reduce the amount of phosphorus in their discharge. When this rule was adopted, a provision was included to allow facilities to employ biological means to reduce the phosphorus in the effluent, an emerging technology at the time. This provision was intended to encourage a more natural means for phosphorus removal in place of the traditional chemical addition and resulting chemical-containing sludge. Although this provision allows facilities to discharge phosphorus at a somewhat higher level than could be achieved by chemical precipitation of phosphorus, this technology has proven to be a workable and less expensive alternative, particularly at municipal wastewater treatment plants.

State regulations require point source discharge limits for phosphorus of 1 milligram per liter for all but the smallest municipalities and industries. Earlier point source discharge limits for phosphorus, which were limited to Great Lakes waters, led to an 85 percent reduction in the amount of phosphorus entering those waters. With the expansion of phosphorus limits to all significant municipal and industrial dischargers statewide, a similar reduction in phosphorus levels should occur for all state waters.

Privately—Owned Wastewater Treatment Systems

The Wisconsin Department of Commerce (DCOMM) has authority under state law to review and approve installation of wastewater treatment systems that use subsurface disposal for the wastewater. These are normally in the form of septic tanks and drain fields, although DCOMM has adopted new rules in early 2000 that allows for the use of alternative treatment methods prior to disposal into the subsurface systems. In 1999, WDNR and DCOMM signed a Memorandum of Understanding that establishes the jurisdictional boundary between the agencies regarding regulation of these types of on-site disposal permits for facilities greater than approximately 12,000 gallons per day, and DCOMM has the review and approval authority for smaller systems. WDNR will begin to issue WPDES permits for these larger facilities (estimated to be in the range of 100 to 200) in 2000. WDNR additionally retains review authority for all sizes of systems that contain and are used for the disposal of non-domestic wastewater. Some of these systems fall within the regulatory authority of Class 5 Injection wells under the Safe Drinking Water Act and are reviewed to conform to those regulations.

Pollution Prevention

Pollution prevention initiatives going on throughout Wisconsin contribute significantly to improving water pollution control efforts. Through their pollution prevention efforts, facilities reduce the pollution they generate, and in the process, save millions of dollars and make Wisconsin's environment a safer, cleaner and more sustainable place to live.

Federal grants from U.S. EPA assist state's efforts to develop and implement pollution prevention related activities. In Wisconsin, efforts are targeted to assist businesses and communities by providing them with information, technical assistance and training on waste reduction.

In the 1999-01 Wisconsin State Budget, statutory language was included that has broaden the definition of pollution prevention. The old definition limited pollution prevention authori-

ties to hazardous pollution prevention. Over the years, it has been found that non-hazardous wastes and emissions are as much of a problem as the hazardous ones or that they were tied to the hazardous emissions. Work gradually shifted to incorporate high volume industrial wastes and secondary impacts such as energy use under the pollution prevention umbrella. This statutory language change brings Wisconsin into conformance with U.S. EPA, other states, and the current thinking about pollution prevention.

There are a number of pollution prevention success stories, which are described below, that have made Wisconsin, and specific communities, more sustainable.

Community Mercury Reduction

In late 1997 and throughout 1998, a Mercury Roundup was funded through a WDNR Recycling Demonstration Grant to Mercury Waste Solutions, a mercury reclamation facility in southeast Wisconsin.

The Mercury Roundup offered free mercury collection and recycling to communities in the state. The Roundup collected 3,579 pounds of elemental mercury, 5,539 pounds of mercury-containing devices, and 104,258 fluorescent lamps (fluorescent lamps contain mercury), from 470 participants. Thanks to this successful program, all of this mercury - collected from schools, dental practices, hospitals and households – was prevented from entering the waste stream and becoming an environmental problem.

The WDNR and partner communities hope to replicate this success through the Wisconsin Community Mercury Reduction Program. This program is a WDNR initiative to empower outreach and collection efforts. Eight communities throughout the state are actively working to virtually eliminate releases of mercury to the environment. The participating seven communities are Appleton, Green Bay, Madison, Marinette, Milwaukee, Kenosha, and Racine. Each community effort is directed through the municipality's wastewater treatment facility. These facilities are particularly interested in this effort since they are often on the receiving end of a community's waste mercury after disposal down drains and other means.

In 1999, WDNR awarded the communities with a Recycling Demonstration Grant, which will allow them to provide a Community Mercury Recycling Program (CMRP) to their communities and surrounding areas. Through each CMRP, very small quantity generators – including schools, dental facilities and householders – can recycle their mercury and mercury-containing products at no cost or at a reduced cost.

The goals of the program are to:

- Prevent improper mercury disposal, thus reducing the amount of mercury going to landfills or wastewater and then entering the environment;
- Eliminate the potential for spills and/or accidental releases of mercury in the environment; and
- Improve the collection potential of mercury-bearing wastes in an innovative way in Wisconsin.

Pulp and Paper Pollution Prevention Partnership

The Pollution Prevention Partnership (PPP) with the pulp and paper industry is now in its sixth year. The program features voluntary reduction in environmental releases by one of the state's largest industries and goes beyond what is required by law. In cooperation with WDNR, the Wisconsin Paper Council coordinates PPP, the industries trade association.

Twenty-five firms and 42 facilities participate in this program, which is designed to find cost-effective ways to reduce potentially harmful by-products from the paper industry's manufacturing process. PPP covers air emissions, wastewater discharges, and solid and hazardous wastes. It also includes voluntary reduction goals for seven "target" substances – chlorine, chloroform, formaldehyde, hydrogen sulfide, methanol, phosphorus and xylene.

One way to measure progress is to compare environmental releases with production data. In 1992, the paper industry released 11.73 pounds of process-related pollutants for every ton of pulp, paper and paperboard produced in Wisconsin. In 1997, it released 5.11 pounds per

ton of production, a drop of 56 percent in just five years. Other achievements since 1992 include:

- Chlorine releases are down 21 percent;
- Overall chloroform emissions are down 47 percent;
- Formaldehyde emissions have declined almost 32 percent;
- Emissions of hydrogen sulfide have decreased almost 14 percent;
- Methanol releases are down 35 percent; and
- Xylene releases are down 28 percent.

Phosphorus releases dropped 13.6 percent during 1997. The major phosphorus dischargers in PPP also conducted minimization studies in 1998-99 to enhance performance while maintaining efficient wastewater treatment.

Toxics Reductions through Pre-treatment Programs

Two pollution prevention initiatives were implemented, one by the Clintonville Department of Public Works, and the other by the Milwaukee Metropolitan Sewerage District (MMSD). In Clintonville, significant industrial dischargers in the community were invited to participate in a voluntary program to help locate and reduce or eliminate phosphorus and toxic loadings to the wastewater treatment plant. The initial activity associated with the project appears to have eliminated both problems. However, a second round of the project will look at small sources of pollutants such as commercial businesses, restaurants, and car washes. In Milwaukee, state specialists either accompanied inspectors or visited targeted businesses separately to provide pollution prevention ideas. Several pollution prevention projects were suggested to companies that historically had discharge problems with MMSD. Follow-up activities are in progress.

Enviro-Partners for Dane County Businesses

In the fall of 1996, a coalition of representatives from a half dozen municipal, county, and state governments, as well as private non-profit and educational organizations, met to pool their experience and enthusiasm to assist Dane County small businesses with adopting environmentally responsible strategies. After surveying the community to identify the business sectors with a priority need for assistance, the new Enviro-Partners for Dane County Businesses formed alliances with businesses and trade associations representing two target sectors: painters and multi-family dwelling property owners/managers.

Based on feedback from targeted businesses, Enviro-Partners has participated in numerous trade shows, prepared newsletter articles for sector trade members, and hosted informational sessions for businesses. Most recently, Enviro-Partners has aided in the Green Built Home Pilot Program with the Madison Area Builders Association's Parade of Homes.

Since the development of a Parade of Homes site begins with an undeveloped plat of land and the planning and building occurs within six months, there appeared to be an opportunity to provide Enviro-Partners' services at each stage of the process:

- Architectural design, including green building siting aspects, stormwater runoff considerations, and low impact landscaping;
- Building material specifications;
- Waste reduction and recycling at building sites; and
- Information about interior finishing – wood finishing, types of wood, energy conservation, and lighting.

The group is working on the documentation of this process with photographs and written materials that describe how business/government partnership impacted the waste reduction behavior of building and associated trades. It also surveyed Parade attendees to gauge consumer knowledge and educate them regarding "green" products and practices.

Management of Polluted Runoff

Urban and rural land use activities are the source of "nonpoint source" pollutants entering Wisconsin's lakes, streams, wetlands and groundwater. Common pollutants in runoff include the following:

- Sediment, pesticides and nutrients from both urban and rural sources,
- Oil, grease, heavy metals, and other toxic materials from impervious surfaces such as streets, highways, roof and parking lots,
- Farm animal wastes from barnyards and pet wastes from urban areas, and
- Sediment from construction sites.

The effects of polluted runoff can be seen in degraded fish habitat, fish kills, over-fertile waters causing heavy weed growth, degradation of drinking water supplies, siltation of harbors and streams, and deminished recreational uses.

To address these pollutant problems, water quality managers encourage "best-management practices"(BMPs). BMPs include use of buffer strips, livestock fencing, manure storage areas, or stream channels to reduce movement of pollutants to surface and groundwater.

Management of pollution runoff is a key component to protecting Wisconsin's lakes and streams.

The state's efforts to restore water resources affected by polluted runoff center around the Wisconsin Nonpoint Source (NPS) Water Pollution Program. Three primary components of the NPS Program include the priority watershed and other financial assistance programs, the stormwater management program and the animal waste program. The management strategy for these three programs is aimed at abating urban and rural nonpoint sources of pollution. Wisconsin has been recognized as a leading state in the effort to control NPS pollution. A comprehensive, redesign of the NPS program is under consideration to further protect and enhance the state's water resources by strengthening state and local programs and partnerships.

Priority Watershed Program

The NPS Program has been implemented primarily through priority watershed and priority lake projects, which provide financial assistance to local units of government in selected urban and rural watersheds. The grants reimburse costs for installing voluntary BMPs.

Since the program began in 1978, 86 of the state's 330 large-scale watersheds have been designated as priority watershed and priority lake projects (see Figure 1). Approximately 125 million in local assistance and cost-share grants have been provided to these priority watershed projects. Twenty-four of the 86 projects have been closed or completed. All but two of the remaining projects have been approved and are in the implementation phase. Table 1 provides a summary of the expenditures (through 6/30/98) and the status for the large-scale priority watershed projects. Table 2 provides a similar summary of the small-scale priority watershed and lake projects. Funding for ongoing watershed and lake projects will continue through 2009.

Over the last three years a number of fiscal management measures were implemented to bring program expenditures in line with the funding. One of these measures includes suspen-

sion of the selection of new priority watershed and lake projects. Other proposed changes are designed to streamline and eliminate program duplication, incorporate animal waste management initiatives, enhance local and intergovernmental partnerships, and shift more decision-making to local units of government at the river basin level.

Control of polluted runoff continues as one of the most important challenges in the state's effort to protect the quality of Wisconsin's water resources. Comprehensive NPS program changes underway will facilitate watershed protection efforts by:

- Reducing agricultural runoff by improving nutrient management from agricultural fields,
- improving manure management,
- eliminating program duplication,
- facilitating a faster, more effective NPS pollution control strategy,
- decentralizing decision-making to local levels of government, and
- strengthening state and local programs and partnerships.

Figure 1. Priority watershed projects in Wisconsin

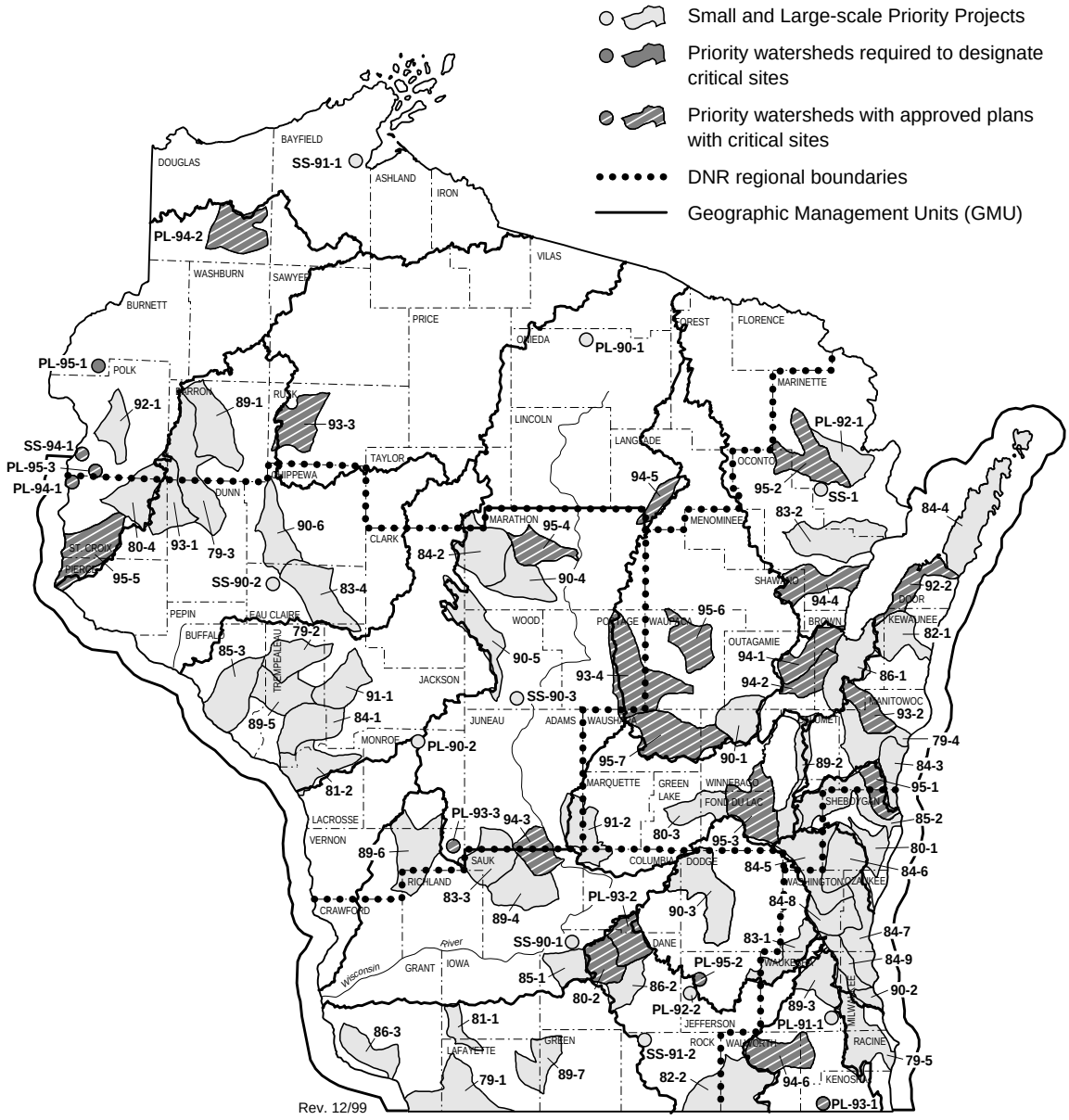


Table 1. Original Nonpoint Source Pollution Abatement Grant Program Expenditures through June 30, 1998—large-scale Priority Watershed Projects

Year Started	Project Name	Location	Size Sq. Miles	Local Assistance	Cost-Share
1979	Galena River*	Lafayette, Grant	241	$120,412	$2,267,305
	Elk Creek*	Trempealeau	112	78,732	1,456,717
	Root River*	Racine, Waukesha, Milwaukee	198	489,057	1,487,593
	Lower Manitowoc River*	Manitowoc, Brown	168	8,224	188,750
	Hay River*	Barron, Dunn	289	29,464	841,307
1980	Big Green Lake*	Green Lake, Fond du Lac	106	312,913	650,435
	Upper Willow River*	St. Croix, Polk	183	53,173	327,522
	Six-mile/Pheasant Branch Creek[1]	Dane	119	2,321	493,293
	Onion River*	Sheboygan, Ozaukee	97	58,324	321,193
1981	Upper W. Branch Pecatonica River*	Iowa, Lafayette	77	9,227	257,049
	Lower Black River*	La Crosse, Trempealeau	189	312,364	1,309,686
1982	Kewaunee River*	Kewaunee, Brown	142	245,452	647,267
	Turtle Creek*	Walworth, Rock	288	586,582	1,482,020
1983	Oconomowoc River*	Waukesha, Washington, Jefferson	130	594,875	283,984
	Little River*	Oconto, Marinette	210	777,206	1,472,807
	Crossman Creek/Little Baraboo River*	Sauk, Juneau, Richland	213	1,616,899	3,846,414
	Lower Eau Claire River*	Eau Claire	399	399,224	833,631
	Beaver Creek*	Trempealeau, Jackson	160	166,794	1,620,347
1984	Upper Big Eau Pleine River*	Marathon, Clark, Taylor	219	696,567	1,119,674
	Seven-mile/Silver Creek*	Manitowoc, Sheboygan	112	291,508	1,188,890
	Upper Door Peninsula*	Door	287	1,161,944	3,085,902
	East & West Branch Milwaukee River	Fond du Lac, Washington, Sheboygan, Dodge, Ozaukee	265	1,474,165	1,288,187
	North Branch Milwaukee River	Sheboygan, Washington, Ozaukee	149	1,151,006	920,188
	Cedar Creek	Ozaukee, Washington	129	1,039,423	866,377
	Milwaukee River South	Ozaukee, Milwaukee	167	3,498,844	2,052,937
	Menomonee River	Milwaukee, Waukesha, Ozaukee, Washington	136	2,594,799	435,448
1985	Black Earth Creek	Dane	105	537,447	1,438,781
	Sheboygan River	Sheboygan, Fond du Lac, Manitowoc, Calumet	260	2,458,390	2,810,634
	Waumandee Creek	Buffalo	221	1,012,313	1,960,199
1986	East River	Brown, Calumet	206	3,099,505	2,139,206
	Yahara River-Lake Monona	Dane	93	1,870,324	1,701,235
	Lower Grant River	Grant	129	906,007	755,710
1989	Middle Trempealeau River	Trempealeau, Buffalo	205	1,948,154	1,882,350
	Lake Winnebago/East	Fond du Lac, Calumet	99	1,546,870	1,343,562
	Middle Kickapoo River	Vernon, Monroe, Richland	246	1,708,024	2,159,465
	Yellow River	Barron	239	713,551	507,422
	Upper Fox/Illinois River	Waukesha	151	1,480,610	148,008
	Narrows Creek/Baraboo River	Sauk	176	1,051,793	1,040,074
	Lower E. Branch Pecatonica River	Green, Lafayette	144	1,573,425	1,463,293
1990	Arrowhead River/Daggets Creek	Outagamie, Winnebago	142	$1,126,115	674,967
	Kinnickinnic River	Milwaukee	33	175,094	0
	Beaver Dam River	Dodge, Columbia, Green Lake	290	1,522,055	1,059,816
	Duncan Creek	Chippewa, Eau Claire	191	1,632,131	728,329
	Lower Big Eau Pleine River	Marathon	138	779,765	786,130
	Upper Yellow River	Wood, Clark, Marathon	212	1,083,038	952,289
1991	Upper Trempealeau River	Jackson, Trempealeau	175	1,075,019	1,132,709
	Neenah Creek	Adams, Marquette, Columbia	173	798,445	227,135
1992	Balsam Branch Creek	Polk	104	669,413	178,965
	Red River/Little Sturgeon Bay	Door, Kewaunee, Brown	139	1,224,298	682,195
1993	Branch River	Brown, Manitowoc	108	1,124,608	482,298
	Soft Maple/Hay Creek	Rusk	176	382,166	72,725
	South Fork Hay River	St. Croix, Dunn, Polk, Barron	181	756,264	21,324
	Tomorrow/Waupaca River	Waupaca, Portage	290	993,927	648,651

Table 1 (Continued). Original Nonpoint Source Pollution Abatement Grant Program Expenditures through June 30—1998 large-scale Priority Watershed Projects

Year Started	Project Name	Location	Size Sq. Miles	Local Assistance	Cost-Share
1994	Apple & Ashwaubenon Creeks	Brown, Outagamie, Oneida Nation	113	589,615	27,499
	Dell Creek	Juneau, Sauk	133	476,768	13,295
	Duck Creek	Brown, Outagamie, Oneida Nation	151	664,885	22,126
	Pensaukee River	Oconto, Shawano	163	461,097	266,490
	Spring Brook	Langlade, Marathon	69	236,262	0
	Sugar & Honey Creeks	Racine, Walworth	166	511,928	59,193
1995	Fond du Lac River	Fond du Lac, Winnebago	244	301,225	50,798
	Kinnickinnic River	Pierce, St. Croix	206	375,889	9,356
	Lower Little Wolf River	Waupaca	152	212,521	104,386
	Lower Rib River	Marathon	129	255,904	0
	Middle Peshtigo & Thunder Rivers	Marinette, Oconto	193	132,244	0
	Pigeon River	Manitowoc, Sheboygan	78	242,856	9,394
	Pine & Willow Rivers	Waushara, Winnebago	303	349,448	38,291
	TOTAL		11,328	$55,828,889	$58,343,223

* Completed Projects

[1]Six-mile/Pheasant Branch is currently a part of the Lake Mendota priority lake project (1993).

Table 2. Original Nonpoint Source Pollution Abatement Grant Program Expenditure Through June 30, 1998—Small-Scale Priority Watersheds, Priority Lake Projects, and Other Grants

Year Started	Project Name	Location	Size Sq. Miles	Local Assistance	Cost-Share
Small Scale Watershed Projects					
1986	Bass Lake*	Marinette	1	$23,026	$94,593
1990	Dunlap Creek	Dane	14	66,740	67,173
	Lowes Creek	Eau Claire	10	198,542	179,818
	Port Edwards Groundwater Project*	Wood	10	157,108	0
1991	Whittlesey Creek	Bayfield	12	222,952	20,912
	Spring Creek	Rock	6	173,907	0
1994	Osceola Creek	Polk	9	120,588	119,523
	Subtotal		122	$962,863	$482,018
Priority Lake Projects					
1990	Minocqua Lake*	Oneida	10	$175,587	$82,001
	Lake Tomah	Monroe	32	293,248	346,691
1991	Little/Big Muskego-Wind Lakes	Waukesha, Racine	41	946,516	256,081
1992	Middle Inlet-Lake Noquebay	Marinette	155	433,993	280,655
	Lake Ripley	Jefferson	8	297,667	19,651
1993	Camp/Center Lakes	Kenosha	8	230,424	0
	Hillsboro Lake	Vernon	35	376,837	272,322
	Lake Mendota	Dane, Columbia	230	1,227,917	0
1994	St. Croix Lakes Cluster	St. Croix	3	174,276	14,379
	St. Croix Flowage & Upper St. Croix Lake	Douglas	45	166,715	6,008
1995	Big Wood Lake	Burnett	20	148,786	0
	Horse Creek	Polk	15	168,859	0
	Rock Lake	Jefferson	10	86,452	0
	Subtotal		552	$4,727,275	$1,277,787
Other Grant Recipients					
	Federal (NRCS, USGS)			$1,238,526	$0
	State Institutions (UW, UWEX)			1,524,702	0
	Regional Planning Commissions			266,138	0
	Other			94,601	0
	Subtotal			$3,123,967	$0
GRAND TOTAL			$8,814,105	$1,759,805	

* Completed Projects

Storm Water Management

Most sediment entering urban lakes, streams, and wetlands originates from construction sites. Construction site pollutants include nutrients (such as phosphorus and nitrogen), heavy metals and oil and grease.

Based on statutory regulations adopted by the Legislature in 1993, the WDNR has issued WPDES storm water permits to Madison and Milwaukee, the two largest Wisconsin municipalities. In addition, general storm water permits have been issued to more than 3,400 industrial facilities, and approximately 400 permits per year have been issued for construction sites.

Model Ordinances for Storm Water Management

Additional protection of surface waters is provided through a model storm water ordinance adopted by the Natural Resources Board in March 2000. Model ordinances for construction site erosion control and storm water management requires review by the legislature. Following legislative review, the WDNR is required to make these ordinances available to local units of government for voluntary adoption.

The purpose of these ordinances is to address the long-term quality and quantity of storm water runoff discharged from urban areas and construction sites. The model ordinance covers land development and redevelopment activity on sites one acre or larger unless the applicable local unit of government determines receiving waters or the drainage system may be damaged.

During the construction phase, performance standards require designing, installing and maintaining of BMPs in accordance with a sediment and erosion control plan for disturbed areas of five acres or more (one acre or more after U.S. EPA Phase 2 Storm water Regulations go into effect). The primary goal of this initiative is to control 80 percent of the average annual sediment load and 60 percent of the average annual phosphorus load by use of design standards.

During the post-construction phase, the standard requires the designing, installing and maintaining of BMPs in accordance with a storm water management plan for the same sites that were subject to the construction performance standard. The goal of this standard is to reduce the average annual total suspended solids load by 80 percent as compared to no controls and reduce the annual average phosphorus and heavy metals loads by 50 percent.

Performance standards for developed urban areas involve control of pollutants to the maximum extent practicable. In the initial stage, the management program focuses on pollution prevention and public education activities like pesticide, nutrient and leaf management and street sweeping, with a targeted reduction for suspended solids of 20 percent and for phosphorus and heavy metals of 10 percent. The second stage includes progressive use of a combination of high efficiency sweepers and structural BMPs with a targeted reduction of 40 percent for suspended solids and 20 percent for phosphorus and heavy metals.

Animal Waste Management

Wisconsin regulates livestock operations with 1,000 animal units or more and those livestock operations with less than 1,000 animals units with discharges significantly affecting water quality. In addition to organic materials, animal waste contains chlorides, nitrogen and phosphorus, among other pollutants. Through NR 243, Wisconsin Administrative Code, some of the worst sites in the state have been addressed. Approximately 40,000 active livestock operations exist in Wisconsin. Of these, about 100 are required to have a Wisconsin Pollutant Discharge Elimination System (WPDES) permit due to their size (more than 1,000 animal units which is a codified measure based on roughly a 1,000 pound steer). The WDNR has experienced a significant increase in the number of facilities applying for permits.

Large livestack operations are required to have WPDES permits

The WDNR is currently in the process of codifying statewide performance standards and prohibitions for all livestock operations. These include manure management prohibitions, nutrient management, manure storage, and soil loss from riparian fields.

Implementation of these standards and prohibitions is intended to occur primarily through counties, although the WDNR will continue to regulate permitted facilities. The WDNR would serve as a back-up implementation mechanism for operators with less than 1,000 animal units.

Notice of Discharge (NOD)

A citizen compliant can be filed against a livestock operator for an animal waste discharge. If a follow-up investigation reveals a significant discharge, a NOD may be issued by the WDNR to the livestock operator. Technical assistance to control the discharge is available through the Land Conservation Districts (LCD) and cost-share financial assistance is available through the Department of Agriculture, Trade and Consumer Protection (DATCP) for the construction of corrective measures. Throughout the process the WDNR may conduct follow-up investigations to monitor compliance. A livestock operator who fails to implement necessary corrective measures within a specified time frame is subject to a loss of cost-share funding from DATCP and may be required to obtain a WPDES permit from the WDNR.

Over the last fifteen years, 566 NODs have been issued; 99 have been since the last 305b report was published in 1996. During this time, DATCP has provided an estimated $1.5 million in cost share funds and technical assistance. In 1998-99, DATCP provided $618,000 in cost-share funding for smaller animal feeding operations to correct deficiencies identified in NODs issued by WDNR. During the same year DATCP also provided $132,000 in technical assistance to livestock operators.

Since 1984, DATCP provided cost-share funding for 271 livestock operators to correct pollution problems. The average grant amount was approximately $19,800. About 54 percent of the livestock operations that receive NODs from the WDNR receive grants from DATCP. Most livestock operations that received funding from DATCP corrected their problem. About nine percent of the livestock operators failed to take required actions under the NOD and have been issued WPDES permits or have a WDNR action pending.

Redesign of the Nonpoint Source Program

Although Wisconsin has made significant progress in addressing NPS water quality pollution since the program began in 1979, a redesign of the program has been proposed to address persistent urban and rural NPS pollution problems. Consequently, the Legislature restructured the NPS program in 1997 and 1999, creating new targeted runoff management, urban NPS, and storm water grant programs. The legislative initiatives were part of Wisconsin Act 27, which required the WDNR and the Department of Agriculture, Trade and Consumer Protection (DATCP) to create NPS pollution standards and to restructure existing programs. Other affected agencies included the Wisconsin Department of Transportation and the Wisconsin Department of Commerce. Restructured programs include manure storage, nutrient management, cropland erosion, construction site erosion and storm water control. The proposed new and revised rules are the result of WDNR and DATCP restructuring efforts.

The most significant program change is the introduction of statewide standards and prohibitions to help the state meet water quality standards. Other changes include giving local governments more power to control NPS pollution, providing a framework for new grant programs, establishing stronger links between agencies and programs addressing polluted runoff, and changing control of NPS pollution to a requirement rather than a voluntary effort in selected watersheds.

Under the proposed new rules agricultural operations would have to meet standards for applying fertilizer, controlling soil erosion from cropland and managing manure. Similarly, municipalities and real estate developers would have to

- meet standards to reduce soil erosion from construction sites,
- control sediment and pollutant runoff from development and redeveloped urban areas,
- develop storm water management plans to address sediment and illicit discharges, and
- implement "good housekeeping" efforts in developed urban areas.

Groups affected by redesign of the NPS program (agricultural, environmental, municipal and producer representatives) assisted in development of the rules. Some of the major program changes include the following:

- **Targeted performance standards—**Uniform adherence to the statewide performance standards and prohibitions are expected to resolve many NPS pollution problems. However, statewide performance standards may be inadequate to meet water quality goals in certain areas. In these areas, targeted performance standards requiring a higher level of treatment or protection may be established by the WDNR or local units of government. Targeted standards may be identified in integrated resource management plans and through local ordinances or promulgated in administrative rules by the WDNR.
- **Agricultural performance standards—**Agricultural performance standards and prohibitions apply to all agricultural sources in Wisconsin. These standards will help meet water quality goals by addressing the following problems: cropland soil erosion control; sheet, rill and wind erosion; concentrated flow channels; and soil loss from riparian fields.
- **Manure storage, management and prohibitions—**To protect water quality, livestock operations must meet the following requirements: 1) no overflow of manure storage structures; 2) no unconfined manure pile within 1,000 feet from a navigable lake, 300 feet from a navigable river or stream, or close to a site susceptible to groundwater contamination; 3) no direct runoff from a feedlot of stored manure into any surface waters; 4) no unlimited access by livestock to surface waters in a location where high concentrations of animals prevent the maintenance of adequate sod cover.
- **Nutrient management—**Nutrient applications, including commercial fertilizers, cannot be applied at rates exceeding crop needs. Unincorporated biosolids (manure and sludge) can not exceed 75 pounds of phosphorus per acre per year. Soil loss can not exceed tolerable limits as set by state standards. The state will identify specific technical standards resulting in compliance with performance standards.
- **Stormwater management—**Refer to the Storm Water Management Section for information concerning performance standards.
- **Implementation—**Implementation of the new performance standards will require the participation of the affected stakeholders. Critical to the success of implementing the standards will by information and education efforts by WDNR, UW-Extension and external partnership teams.
- **Financial assistance—**The program redesign will improve the delivery of financial assistance through two fundamental changes. The first change involves identification of funding as either general or targeted. General funding applies only to rural grantees and consists of all counties receiving a base level of funding for program administration and for installation of conservation practices. Counties will determine priorities for use of general funding within legal limitations. Targeted funding will be provided to

Fencing to control livestock access and buffer strips are critiacal in protection water quality.

both rural and urban grantees and is aimed at specific water quality projects. The second change includes institution of a clearinghouse to match funding sources from participating agencies to fund local and state priorities.

Environmental Improvement Fund

During the latter part of the 1990s, the creation of the Environmental Improvement Fund (EIF) changed Wisconsin's approach to correct water quality problems by providing a new approach for funding. When fully implemented, the new funding mechanism will direct limited financial resources to the projects that provide the greatest benefits. The EIF funding system should provide Wisconsin the ability to best meet its responsibilities under the 1987 Clean Water Act.

The new EIF legislation incorporated three separated programs: the Clean Water Fund Program, the Safe Drinking Water Loan Program and the Land Recycling Loan Program (brownfields). The latter two programs were first established separately in 1997 and then consolidated with the existing Clean Water Fund Program, which has been around since 1988. EIF programs provide financial assistance to local units of government for wastewater treatment, drinking water and contaminated land cleanup projects. The WDNR is in the process of incorporating a stormwater and non-point program into the EIF.

Clean Water Fund Program

The Clean Water Fund Program CWFP) is the name Wisconsin uses for its revolving loan program that was developed following the 1987 amendments to the Clean Water Act. The CWFP began making loans in 1991, using funding from the capitalization grant authorized by the Clean Water Act. Supplemental funding, generated through state borrowing, was also available as a means to leverage the federal capitalization grant. The CWFP has been crucial in helping achieving the state's water quality goals and the objectives of the Clean Water Act. In addition, the repayments of principle and interest from CWFP loans will make up the primary source of funding for future EIF programs. The programs are administered jointly by WDNR and the Department of Administration.

The CWFP provides financial assistance to municipalities for planning, design and construction of surface water and groundwater pollution abatement facilities. Since 1991, the CWFP shifted the state's financing of wastewater treatment facility construction from grants to loans. An increased emphasis was placed on preventive maintenance for existing pollution abatement facilities. The CWFP replaced the point source pollution abatement grant program, which provided grants for municipalities for wastewater treatment systems from 1978-90.

Financial assistance is administered by the CWFP through: 1) a federal revolving loan program, 2) a state leveraged loan program, 3) a state direct loan and hardship program, 4) a federal hardship program, and 5) a small loan program. The state programs are a commitment made by the Legislature to exceed the federal funding for surface water pollution abatement.

From 1991-99, the Clean Water Fund Program has entered into 426 financial assistance agreements with Wisconsin municipalities totaling $1.25 billion in loans, $96.5 million in financial hardship assistance grants, and $674,010 in interest rate subsidy payments. Individual loans have ranged from $25,000 to over $67 million. The Milwaukee Metropolitan Sewerage District, which is comprised of 29 individual municipalities serving a population of about 1.1 million, has received 23 CWFP loans totaling over $285 million. This amount represents 23% of the CWFP's total loan dollar volume since the program began in 1991. Figure 2 shows the CWFP loan and grant dollars awarded for financial hardship to municipalities for each year from 1991-99. Figure 3 shows the correlation between population and number of projects funded by the program.

Figure 2. CWFP loan and grant dollars awarded.

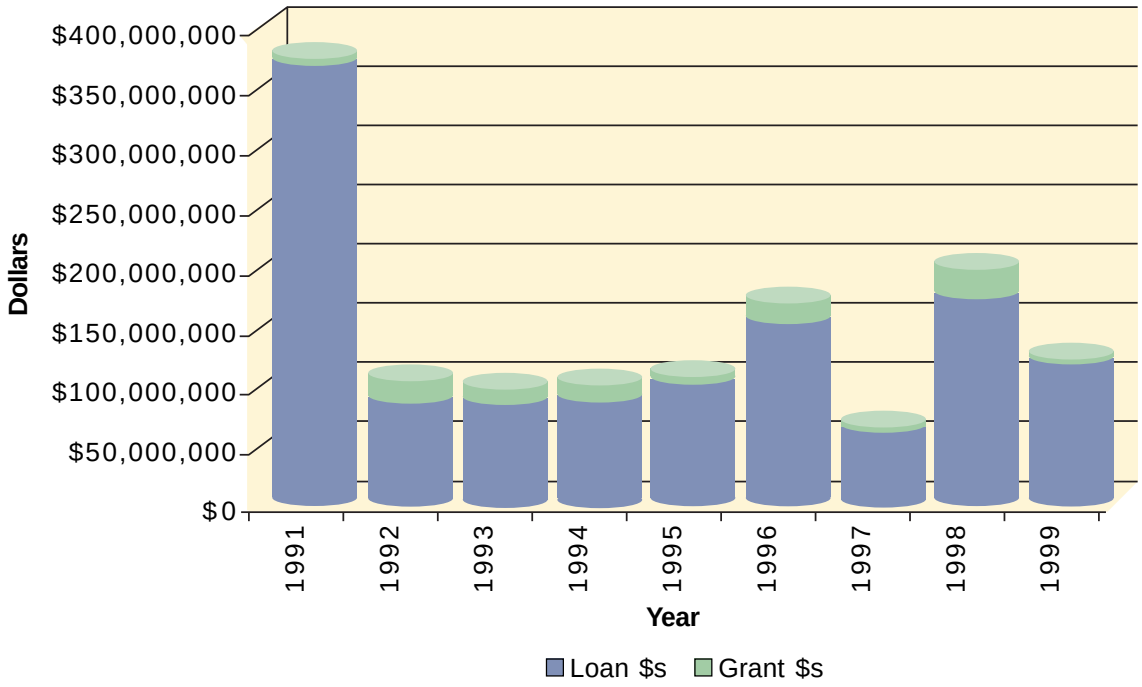
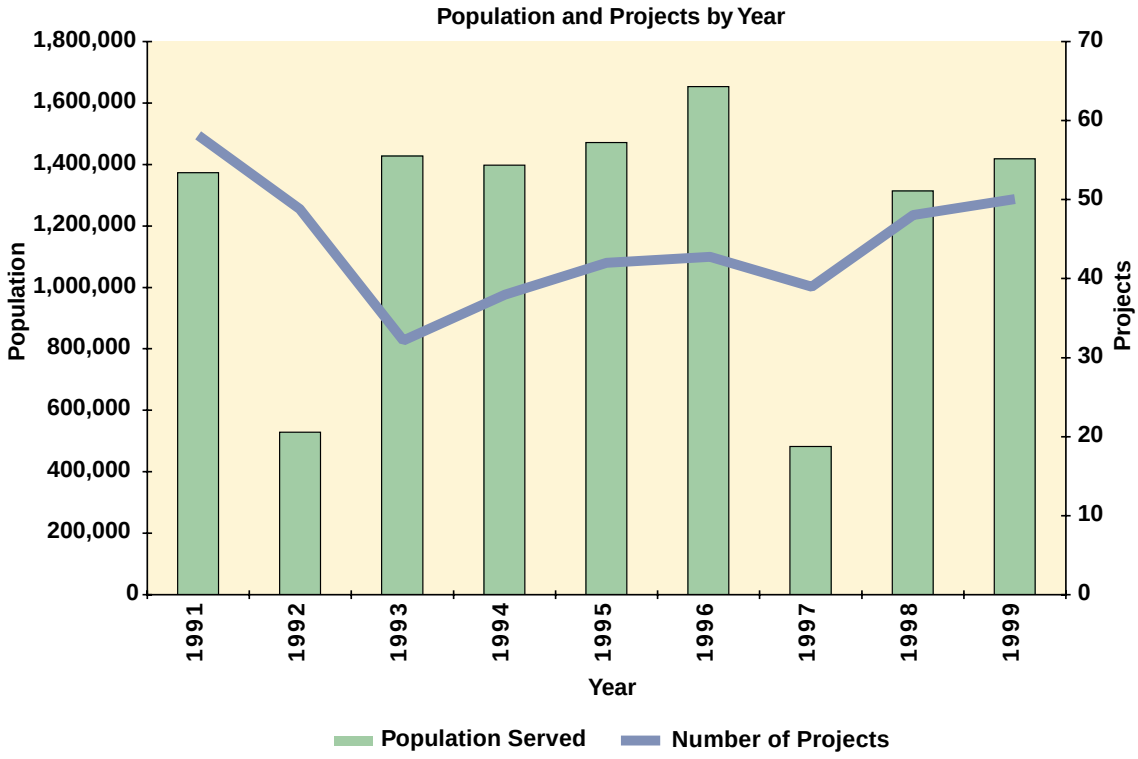


Figure 3. Correlation Between Population and Number of Projects Funded by Program.



The CWFP provides financial assistance for the following types of wastewater projects:

- Compliance maintenance projects – These projects are necessary to prevent a municipality from exceeding effluent limitations contained in their Wisconsin Pollution Discharge Elimination System (WPDES) permit.
- New or changed limits projects – These projects are necessary for a municipality to meet effluent limitations contained in its WPDES permit which were newly established of modified after May 17, 1988.
- Unsewered projects – These projects provide treatment facilities and sewers for unsewered or partially unsewered municipalities.

Under the CWFP, municipalities may receive financial assistance in the form of loans, grants, refinancing, and interest subsidy payments as follows:

1. provide loans at or below market interest rates,
2. provide grants under a financial hardship assistance program,
3. purchase or refinance the debt obligations of a municipality incurred for CWFP eligible wastewater treatment facilities, and
4. make subsidy payments to municipalities to reduce interest on loans made by the Board of commissioners of Public Lands for eligible CWF wastewater treatment facilities.

Each project is prioritized using a system established by Wisconsin Administrative Code. The environmental criteria used to select projects include: impacts to human health, maintenance of fish and aquatic life, maintenance of wild and domestic animals, impacts to outstanding and exceptional resource waters, the ability to treat septage and leachate, and the population served by the project. The priority system assigns a score to every project based on the criteria. Projects are ranked numerically, so in the event funding is not available for all requested projects in a given year, awards will be made by the order in which they are ranked. Funding has been sufficient to fund all eligible clean water fund projects, except for those projects requested under the financial hardship assistance program.

Safe Drinking Water Loan Program

The Safe Drinking Water Loan Program was enacted in 1997 to provide financial assistance to certain municipalities for the planning, design, construction or modification of public water systems. To qualify, projects must comply with national primary drinking water regulations under the Federal Safe Drinking Water Act or otherwise significantly further the health protection objectives of the Act. The Safe Drinking Water Loan Program also provides funds for a Safe Drinking Water Loan Guarantee Program. It guarantees drinking water loans to borrowers who are not local governments and who meet certain conditions. The safe drinking water loan program began providing assistance in 1998. In the first year of operations it provided 10 loans for almost $53 million.

Acquisitions and Easements

WDNR Bureaus of Facilities and Lands and Community Financial Assistance manages the Stewardship Program, which provides funding for a variety of land acquisitions and easements that protect natural resources and increase public recreational opportunities. Many acquisition projects benefit water quality because they usually receive higher priority for funding. Typical project areas include streambank corridors, natural areas, habitat restoration areas, urban greenspace and large river corridors. Funding through Stewardship has helped to establish large areas of public ownership along waters such as the Lower Wisconsin State Riverway, the Turtle Flambeau Flowage Scenic Waters Area, the Willow Flowage and the Dells of the Wisconsin River State Natural Area. Stewardship has also funded a number of recreational development projects, primarily for the State Park and Trail System.

This funding is distributed among 12 separate categories that cover a range of purposes from acquisition to development of support facilities. Grants are also provided to municipalities and nonprofit organizations for acquisition of land or easements to benefit conservation recreation.

In addition to the Stewardship Program, the Nonpoint Source Pollution Abatement Program provides funding for WDNR easements to reduce polluted runoff. This program has funded approximately $1.9 million for purchase of 53 easements totaling 1,144 acres.

Of the 12 Stewardship categories, the Streambank Protection Program is the most focused on water quality protection. Its purpose is the protection of water quality and fishery habitat by acquiring buffer areas along streams. This program provides funding for WDNR projects and provides cost sharing to municipalities and nonprofit organizations. Approximately $6 million has been spent for WDNR streambank projects, and about $1.6 million in grants have been provided to municipalities and nonprofit organizations for 21 projects. The WDNR has targeted 146 stream corridors with a goal of 21,075 acres for easements and 19 stream corridors totaling approximately 130 miles for acquisitions.

The Urban Rivers Program provides 50% cost-sharing grants to municipalities and nonprofit organizations for acquisition of land or rights in lands along urban rivers. The purpose of this program is to promote economic revitalization of urban riverways through restoration, protection or enhancement of the riverways natural values and recreational opportunities. Since the creation of this program, over $12 million has been provided to 123 community projects.

The other categories of the Stewardship Program include a wide range of acquisition purposes all with the intent of preserving or enhancing natural resources as well as providing public recreational opportunities. Although these areas may not have water quality protection as a primary purpose, they do provide water quality protection by preserving green space and incorporating proper land management practices. Expansions of wildlife management areas, fisheries areas, natural areas, state parks, and habitat restoration areas are primarily funded through the Stewardship Program.

The Stewardship Program funding has been authorized for $46 million annually for the next 10 years beginning in July 2000. This is a substantial increase from the $23 million available on an annual basis over the past 10 years. Funding is provided for acquisitions or easements by the WDNR, and in the form of grants for municipalities and nonprofit organizations.

Management of properties owned by the WDNR is outlined in master plans for each property. These plans cover maintenance, management, and development that will occur on the property for at least 15 years. Contained in the plans are recommendations for a variety of land management and recreational activities, especially for those properties that include large water features that are aimed at protecting water quality and scenic natural features. Master plans for properties such as the Lower Wisconsin Riveway, Brule River State Forest, Turtle-Flambeau Flowage Scenic Waters Area, Chippewa Flowage, and Dells of the Wisconsin River State Natural Area contain provisions for protection of water quality and scenic beauty.

Surface Water Assessment and Ecosystem Health

Monitoring

Comprehensive monitoring is crucial to the assessment of water resources and ensuring the attainment and maintenance of Clean Water Act goals. Without monitoring, effective management could not take place. We would have no means of tracking threats to human and ecosystem health, nor could we prove progress when cleanup efforts occur.

Surface Water Monitoring

Historically, much of the water resource assessment work done by the WDNR has focused on degraded watersheds or evaluation of water resources with high public profile. As a result, there is a lack of data on the overall quality of Wisconsin's water resources. In addition, monitoring techniques often varied among assessment sites and over time thus making it difficult to compare data across the state or from different time periods. To address these concerns, the WDNR has initiated a new program in 1999, called Baseline Monitoring. Standardized assessment techniques for aquatic habitat, macroinvertebrates and fish have been developed and are being applied throughout the state.

Monitoring of surface waters provides valuable information on ecosystem health.

The elements of this new program are contained in a draft report on Wisconsin's Surface Water Monitoring Strategy. The document was submitted to U.S. EPA for review in early 2000. Subsequently, WDNR and U.S. EPA Region V staff met to discuss aspects of Wisconsin's monitoring program and specific changes that were necessary for incorporation into an improved document. The WDNR is in the process of revising the Monitoring Strategy and an implementation plan for the upcoming monitoring season and will be resubmitting them to U.S. EPA Region V for final review.

To get broad spatial coverage, assessment efforts are stratified across different sizes of streams and lakes in each basin, so that a variety of resources are assessed. The overall goals of the baseline monitoring strategy are to answer the following questions:

- What are the use expectations for Wisconsin's water resources?
- Are the state's waters meeting their use potential?
- What factors are preventing the state's water resources from meeting their potential?
- What is the statewide status and trends in the quality of Wisconsin's surface waters?

More emphasis is being placed on biological monitoring to determine if waterbodies are meeting their designated uses.

To achieve the goals of the program, the following specific set of monitoring objectives were established:

- Determine the designated attainable uses of each waterbody. Stream and lake habitat information (including volume, temperature and limited water chemistry) and fisheries data collected during baseline assessments will be compared with biological criteria obtained from "least-impacted" regional reference waters to determine the water's use classification.
- Determine the level of use attainment of each waterbody. Stream habitat and fisheries data collected during baseline assessment monitoring will allow the WDNR to determine if waterbodies designated uses are being attained.
- Determine why some waterbodies are not attaining their designated uses. Physical, chemical and biological data collected during baseline assessment monitoring will provide some, if not all of the information needed, to determine why streams are not meeting their designated uses.

The monitoring data will be captured electronically in a centralized database to improve data analysis and dissemination of information. The resulting information will be readily accessible to all resource stakeholders and management partners.

Fixed Station Monitoring Network

WDNR financially supports the United States Geological Survey's (USGS) network of long-term continuous flow monitoring stations. Figure 4 shows the location of the continuous records for the data collection stations throughout Wisconsin. Other financial contributors to USGS for the monitoring network include cities, counties, planning commissions, Native American tribes, regulated power companies, the Illinois Department of Transportation, and the U.S. Army Corps of Engineers. WDNR currently funds 10% of the cooperator's share of the long-term sites.

Surface water information from these sites is needed for surveillance, planning, design, hazard warning, operation, and water management in various fields. These include water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water resource development. The USGS study provides continuous discharge records for selected rivers at specific sites to supply the needs for regulation, analytical studies, definition statistical properties, trend analysis, and determination of the occurrence and distribution of water in streams for planning. The project is also designed to determine lake-levels and to provide discharge for floods, low-flow conditions and for water quality investigations.

USGS provides constant, high-quality flow data for the sites they monitor. Reports of daily average flows for all sites are published in their annual report entitled "Water Resources Data Wisconsin". In addition, real time provisional data of current flows are available on the web site for immediate regulatory and recreational uses (http://wi.water.usgs,gov/).

Prior to 1996, WDNR funded the cooperator's share of almost a third of USGS's long-term flow gauging sites, but budget cuts forced the agency to cut back on its support. USGS has been successful in soliciting funding from other cooperators to keep the number of stations operating in Wisconsin fairly constant. Continued budget cutbacks at other agencies will make funding of these long-term stations a concern.

Figure 4. Location of long-term continuous-record streamflow-gaging stations in Wisconsin, 2000.

Biological Monitoring

In the past, most natural resource management agencies across the country have relied heavily on water chemistry data as the primary measures of water resource quality. This is due, in part, to the fact that point source dischargers were having significant impacts on surface waters. With greater control of point sources, nonpoint source pollution and water use remain the greatest threats to the integrity of Wisconsin's waters.

Because nonpoint source pollution is much more difficult to assess than point sources, new biological assessment techniques have been developed to measure nonpoint impacts. Biological indicators for aquatic ecosystem health rely on invertebrate and fish community data to assess nonpoint impacts. Since these organisms live in Wisconsin's streams, lakes and wetlands year around, they are good indicators of nonpoint pollution stressors that occur over time. Such impacts are often missed by conventional water monitoring techniques.

For stream monitoring, information is collected on riparian and in-stream habitat data, aquatic insects and fish species. The aquatic insects are identified and the numbers of fish are determined using standardized collection protocols. Lake monitoring involves collecting trophic state data and fish community data using the standardized protocols.

WDNR will begin using a stratified-random sampling approach to get adequate coverage of the state's 55,000 miles of streams. This sampling design allows the WDNR to sample a variety of streams and lakes across the state and also provides the ability to evaluate the quality of water resources that have not been sampled.

The WDNR collects over 400 aquatic invertebrate samples per year. In the future, maps showing the location of biological sampling sites will be available. With the baseline monitoring that was initiated last year, the WDNR is assessing about 600 stream sites a year.

Modeling

WDNR uses water quality modeling to assist in making decisions on managing water resources. Modeling helps assess the assimilative capacity of a stream (how much a stream can carry and dilute without harming aquatic life) or the movement of pollutants in an aquatic ecosystem. Models are also useful tools to help determine causes of existing water quality problems, to evaluate responses to proposed management options and to predict future changes likely to occur without any management action.

Development of water quality models often requires the collection of extensive amounts of data on existing water quality and stream flow, as well as the many factors that can affect water quality. Data requirements vary depending on the type of model and its intended use. WDNR uses models in the following areas:

- Stream dissolved oxygen models for waste load allocations
- Contaminated sediment transport models
- Watershed loading models
- Lake response models
- Mixing zone models

Beginning in the mid-1970s, WDNR developed waste load allocation models on stream segments such as the Wisconsin and Fox Rivers where multiple point sources contributed to water quality problems. The allocations were used to establish water quality based effluent limits for industrial and municipal point source discharges. The WDNR is currently re-evaluating allocations for Segment A of the Wisconsin River from Rhinelander to Tomahawk.

Contaminated sediment transport models are used to predict the transport and fate of sediments containing chemicals of concern. In particular, WDNR models sediments containing high levels of polychlorinated biphenyls (PCBs) to determine the rate of PCB movement and the biological concentration of the chemical in the food chain, and to predict the potential benefits from selected cleanup options. WDNR has applied these models to the Lower Fox, Sheboygan and Milwaukee River systems.

Watershed loading models link potential pollutant loads from various land use practices to the amount of pollutant loads in streams and lakes. WDNR uses both screening level and export coefficient models, as well as more detailed and more mechanistic process based models such as the Soil and Water Assessment Tool (SWAT), the Barnyard Evaluation Model (Barny), the Source Loading and Management Model (SLAMM) and Walker's Urban Catchment Model. WDNR is also working with consultants within Wisconsin and with the U.S. Department of Agriculture and the developers of SWAT, to test and refine SWAT for use in northern climates. SWAT is also being examined for use in modeling Total Maximum Daily Loads (TMDLs) in Wisconsin in the future.

Lake models predict the changes in lake eutrophication levels, as reflected in water clarity and the severity of algae blooms, to changes in nutrient loading to a lake. The purpose is to determine how individual lakes will respond to changes in land management practices or possible lake restoration activities. The Wisconsin Lakes Modeling Suite (WILMS) model was developed by the WDNR for Wisconsin by different researchers. It is used for about 80% of the six to eight lakes modeled per year in Wisconsin. WILMS also is used extensively by consultants working on lake planning and protection grants. The Bathtub model from the Army Corps of Engineers is used for the other 20%.

WDNR reviews mixing zone models that are part of applications for modified mixing zones for industrial and municipal dischargers. Results are used to determine effluent limits for toxic compounds to protect fish and aquatic life in the receiving waters. Mixing zone models are a tool for determining the extent to which a diffuser outfall enhances rapid mixing of the effluent and reduces toxicity to aquatic organisms that may be caused by specific pollutants.

Fish Tissue Monitoring

WDNR operates a significant fish tissue-monitoring program. Over the past 5 years, an average of 930 samples was analyzed by the state each year (Table 3). These samples were from inland lakes and rivers and the Great Lakes. Samples from the Great Lakes were analyzed for PCBs, pesticides, and mercury, while samples from river systems were analyzed for PCBs and mercury. Fish samples from inland lakes were analyzed almost exclusively for mercury.

When tissue concentrations exceed levels of concern, consumption advisories are issued for the waterbody and fish species in which the high concentrations were found. In addition, WDNR uses fish tissue monitoring for source investigation, to track the effectiveness of remediation efforts, and to determine potential effects of toxic substances and contaminated sediments on fish-eating birds and wildlife.

Consumption advisories are issued on waterbodies where levels of concern are exceeded.

Fish tissue sampling efforts focus on sites where fish may accumulate contaminants to levels that could be of concern to human health. Sampling sites are chosen based on past contaminant data and the need to assess new sites. Criteria for selection include: sites of industrial discharge or other suspected sources of bioaccumulative contaminants, where large amounts of nonpoint source pollutants enter the water, lakes with large populations of game fish, and waterbodies with significant angler popularity. The state also has an agreement with the Great Lakes Indian Fish and Wildlife Commission to cooperate on collecting fish contaminant data from waters of the Ceded Territory and use the data for issuing consumption advisories.

Prior to 1999, fish were collected annually for contaminant analyses based on the state's basin assessment schedule. Waters within the major river drainage basins were slated for assessment on a five-year rotating schedule.

The WDNR initiated a new baseline monitoring strategy in 1999, for lakes and "wadable," and "non-wadable" rivers and streams. The new strategy is to: 1) collect fish for contaminant analyses from sites where little or no data exists, 2) determine statewide distribution of

Table 3. Wisconsin's Fish Contaminant Monitoring Summary

Year	Number of Sites Tested	Number of Samples	New Advisories Issued
Prior to 1996	2,310	25,788	254
1996	106	1299	N/A
1997	67	849	68
1998	62	817	13
1999	72*	625*	11
Total	2,535	29,378	346

* estimated at time of publication

contaminants, 3) provide a comparison of the levels of contaminants between impacted and unimpacted (reference) sites throughout the state, and 4) assess whether more intensive monitoring is needed at any particular site. The goal of the program is to collect and analyze fish from 125 lakes, 25 wadable stream segments, and 45 non-wadable river segments each year. During the startup of the program in 1999, an abbreviated sampling schedule was followed as reflected in the number of samples shown in Table 3.

In addition to baseline monitoring, special assessments are also a key component of the program and are used to update advisory waters and those involved in remediation efforts. Another major element of the fish contaminant-monitoring program is the assessment of contaminant levels for Lakes Superior and Michigan and their tributaries. This 10-year assessment requires the collection of game and forage fish species biennially with the primary purpose to determine contaminant trends and geographic patterns of contamination.

Public Health Fish Advisories

The fish advisory for all state waters entitled, "Health Guide for People Eating Fish from Wisconsin Waters", is issued annually in the spring. Fish advisories were not issued in 1995 and 1996 pending the approval of a revised protocol for issuing advisories for fish containing PCBs. In 1997, the state issued it's first advisory using the new protocols. Prior to that time, fish containing PCBs were placed on the advisory only when the fillets contained more than 2.0 ppm PCBs. Consumers were advised not to eat any fish over this level, while no advice was given for fish below this level. With the adoption of the new protocols, Wisconsin began giving graduated advice for fish containing as little as 0.05 ppm PCB and up to 1.9 ppm. As a result, waters that were previously tested and contained low, but detectable concentrations of PCBs, were now added to the advisory. Refer to Table 4 for a list of health criteria used for Wisconsin's advisories.

Table 4. Wisconsin Fish Consumption Advisory Guidelines

Contaminant	Concentration	Advice
PCB[1]	0 – 0.05 ppm	Unlimited Consumption
	0.05 – 0.2 ppm	1 meal/week or 52 meals/year
	0.2 – 1.0 ppm	1 meal/month or 12 meals/year
	1.0 – 1.9 ppm	6 meals/year
	> 1.9 ppm	Do Not Eat
Mercury[2]	0 - 0.5 ppm	Unlimited Consumption
	0.5 – 0.75 ppm	Sensitive Population – Do Not Eat Nonsensitive Population – 26 meals/year
	0.75 – 1.0 ppm	Sensitive Population – Do Not Eat Nonsensitive Population –13 meals/year
	> 1.0 ppm	No one should eat
Dioxin[3]	< 10 ppt	No Advice Given
	> 10 ppt	No one should eat
Chlordane[4]	< 0.3 ppm	No advice given
	> 0.3 ppm	No one should eat

[1]Although this advice is based on reproductive health effects, the same advice is given for women, children and men to protect against other potential health effects such as immune suppression and cancer.
[2]Sensitive group includes women of childbearing age and children under age 15.
[3]Sum of total dioxin equivalence expressed as 2,3,7,8 TCDD.
[4]Currently under revision by the Great Lakes Fish Advisory Task Force.

In 1997, sixty-eight waters were added to the advisory. The large number is due primarily to the fact that no advisories were issued the previous two years. Thirteen waterbodies were added to the advisory in 1998 and 11 in 1999. In all, the advisory lists fish from 346 of the more than 2500 lakes, river segments, and border water tested (see Table 3). The increase in the number of advisories is not due to a decline in water quality, but rather, a result of Wisconsin's effort to continually monitor new waters.

Ecosystem Health Assessment

Ecosystem health is assessed through biological monitoring.

Biological monitoring has become an increasingly important component of ecosystem health assessment. In the past, water chemistry data was relied on more heavily to assess the quality of the state's water resources. This is slowly changing as new biological assessment techniques become available to evaluate the health of the aquatic community. For streams, the biological indicators that are used most frequently to monitoring aquatic ecosystem health are macroinvertebrates and fish. For lakes, biological assessment consists of evaluating the fish community and frequently aquatic macrophytes and the plankton. Biological organisms are good to use to evaluate water quality, because they are indicators of what pollution stressors are occurring over time. The WDNR's new baseline monitoring program relies to a large extent on biological data to assess the quality of Wisconsin waters and to determine if waterbodies are meeting their designated uses.

Aquatic Life Toxicity Testing

The WDNR works cooperatively with the University of Wisconsin-Madison's State Laboratory of Hygiene (SLH) to maintain a toxicity-testing laboratory. This laboratory maintains cultures of several fresh water species and is capable of performing acute and chronic toxicity tests on effluent, ambient waters, and sediment samples collected statewide. The laboratory also provides sample collection services for these and other tests. Laboratory staff participates on WDNR policy teams dedicated to the development of new and improved toxicity testing methodologies. Since 1997, the laboratory has been developing algae toxicity test methods (with Raphidocelis subcapitata) for future addition to the chronic toxicity test battery required in Wisconsin Pollutant Discharge Elimination System (WPDES) permits. Additionally, WDNR and laboratory staff assesses the applicability of alternative toxicological assessment methods to other WDNR watershed management programs.

Each year, the laboratory accepts requests for toxicity testing from WDNR basin engineers and permits staff. WDNR staff selects facilities to be tested by the laboratory in order to collect data for compliance inspections, permit reissuances, or enforcement situations. The number of tests completed in Fiscal Years 1998-99 (see Table 5) are down significantly from previous years, due to the relocation of the lab in January 1999. Excluding monthly batteries of reference tests, acute and chronic test batteries performed on WPDES-permitted facilities made up the majority of toxicity tests conducted in Fiscal Years 1998 and 1999. Specifically, 49 acute test batteries were performed on wastewater effluent using two freshwater species: a waterflea (*Ceriodaphnia dubia*) and juvenile fathead minnows (*Pimephales promelas*). Municipal effluent accounted for 28 of those test batteries, while the remaining 21 came from industrial dischargers. While the majority of wastewater effluent samples were non-toxic, 14 indicated a high potential for acute toxicity (8 municipal, 6 industrial). Ammonia toxicity was attributed to 2 of the municipal facilities that experienced acute toxicity. What caused the toxicity was not determined in the remaining cases, but is being addressed via WPDES permitting activities. Additional testing and/or toxicity identification will be recommended in future WPDES permits to further characterize the potential for significant effluent toxicity from these facilities.

Table 5. Summary of SLH toxicity test results for fiscal years 1998-99.

Sample type	#of acute tests	Results		#of chronic tests	Results	
		Pass	Fail		Pass	Fail
WPDES Industrial	21	15	6	8	6	2
WPDES Municipal	28	20	8	17	11	6
Sediment	0	—	—	2	—	2
Ambient Surface Water	15	9	6	10	3	7
Totals	64	44	20	37	20	17

Chronic toxicity test batteries using, C. dubia, larval fathead minnows, and algae (R. subcapitata) were also conducted for 25 facilities: 18 municipal and 7 industrial. Ammonia toxicity was attributed to 2 of the municipal facilities that experienced chronic toxicity. What caused the toxicity was not determined in the remaining cases, but is being addressed via WPDES permitting activities. Additional testing and/or toxicity identification will be recommended in future WPDES permits to further characterize the potential for significant effluent toxicity from these facilities.

WDNR's sediment management program continues to benefit from the ability of laboratory staff to conduct sediment toxicity tests. Acute and chronic toxicity tests using C.dubia, a midge larvae (*Chironomus tentans*) and an amphipod (*Hyalella azteca*) were performed on 2 sediment samples in Fiscal Years 1998 and 1999.

The lab also applied the acute and chronic toxicity testing techniques to several additional sample types, including:

- to assess the toxicity of stormwater runoff samples from the Milwaukee airport;
- to assess acute and chronic toxicity of ambient surface water samples;
- to assess toxicity of samples from Fox River sediment remediation projects;
- to determine "safe levels" of polymers used to treat stormwater retention ponds;
- to assess the cause of fish kills and in emergency spill situations;
- to determine the potential impacts to surface waters from landfill leachates.

WDNR and the SLH efforts in the next biennium will continue to emphasize monitoring for WPDES-permitted facilities. Efforts will also be made to generate additional ambient toxicity data and to supplement the toxicological database for compounds needing water quality criteria.

In addition to WDNR toxicity monitoring conducted by the SLH, WPDES-permitted facilities are evaluated to determine their potential for acute and chronic toxicity. If it is determined that potential for toxicity is present, permits may require that acute and/or chronic Whole Effluent Toxicity (WET) tests be performed. The need for WET testing is evaluated using data regarding available dilution, industry type, type and number of industrial contributors to municipal treatment plants, detection of chemical-specific compounds, additive use, and other factors.

In Fiscal Years 1998-99, 290 WPDES-permitted facilities (172 municipal, 118 industrial) conducted 558 acute tests, as required by their permits (see Table 6). Twenty-four of the 292 tests (8%) conducted by municipal dischargers demonstrated positive acute toxicity. Only two municipal facilities had severe or repeated (>2) occurrences of acute toxicity. Forty-four of 266 tests (16.5%) conducted by industrial dischargers demonstrated positive chronic toxicity. Five industrial dischargers had severe or repeated (>2) occurrences of acute toxicity. Additional testing and/or toxicity identification will be recommended in future WPDES permits to further characterize the potential for significant effluent toxicity from these facilities.

Table 6. Summary of WPDES toxicity test results for fiscal years 1998-99.

Sample type	#of acute tests	Results		#of chronic tests	Results	
		Pass	Fail		Pass	Fail
WPDES Industrial	292	268	24	340	261	79
WPDES Municipal	266	222	44	172	113	59
Totals	558	490	68	512	374	138

In Fiscal Years 1998-99, 222 WPDES-permitted facilities (147 municipal, 75 industrial) conducted 512 chronic tests, as required by their permits. Seventy-nine of 340 tests (23%) conducted by municipal discharges demonstrated positive chronic toxicity. Nine municipal facilities had severe or repeated (>2) occurrences of acute toxicity. Fifty-nine of 172 tests (34%) conducted by industrial dischargers demonstrated positive chronic toxicity. Nine industrial dischargers had severe or repeated (>2) occurrences of acute toxicity. Additional testing and/or toxicity identification will be recommended in future WPDES permits to further characterize the potential for significant effluent toxicity from these facilities.

WDNR efforts in the next biennium will continue to emphasize compliance monitoring and toxicity identification and reduction for WPDES-permitted facilities.

Contaminated Sediment Management

Sediment sampling is important in determinig the degree and extent of contamination.

The state has created a specific standing team to actively develop and implement an effective, integrated and consistent program to deal with contaminated sediment sites. The Contaminated Sediments Standing Team develops policies and procedures and guidance for:

- the identification and inventory of sites,
- an assessment of environmental and human health impacts, and
- enhancement of water quality in Wisconsin's surface waters.

The team will develop a contaminated sediment management strategy as required in the state's Environmental Performance Partnership Agreement with U.S. EPA.

Completed Sediment Remediation Projects

Over the last few years, contaminated sediments at a number of sites have been remediated through various programs and methods. All of the sites have generally proceeded through a decision making process that included site investigations and site specific studies, such as toxicity testing of sediments and surveys of the benthic macroinvertebrate communities. The process also involves human health and ecological risk assessments as appropriate, feasibility studies that looked at remedial alternatives, and selection, design, and implementation of the remedial alternative.

Vulcan Chemicals

This site is located at the Port Edward's facility on the Wisconsin River. Vulcan Chemicals owns and operates a mercury cell chloralkali facility and manufactures chlorine, hydrochloric acid, sodium hydroxide, potassium hydroxide and potassium carbonate. Releases of mercury constituents from certain solid waste management units resulted in the facility entry into the Resource Conservation and Recovery Act (RCRA) corrective action program. Elevated levels of mercury, associated with wetland sloughs adjacent to the Wisconsin River east of the plant, originated primarily from: 1) a 1976 tank failure that resulted in some 440,000 gallons of brine solution containing mercury entering the wetlands, and 2) mercury contaminated groundwater originating under processing buildings of the plant moving toward and discharging to the wetlands. Cleaning of some portion of the wetland soils took place after the 1976 spill but still left residual mercury levels. Under WDNR lead, the company undertook corrective actions. These actions included installing a groundwater collection system to intercept, pump, and treat contaminated groundwater moving towards the wetlands and Wisconsin River and remediating mercury-contaminated soils of the wetlands by evacuation. Remediation of the soils of the wetland sloughs took place in September 1998. The downstream dam on the Wisconsin River was opened to lower water levels over the areas to be remediated to allow access by equipment. During remediation, the sloughs were isolated from the river. Approximately 6,200 cubic yards of contaminated soils and sediments were removed from the sloughs and wetland areas and high ground area between the wetlands. The cleanup was driven by the local background level of mercury in wetland soils that were not impacted.

Wausau Steel Corporation

This site is located in Wausau on the Big Rib River. Wausau Steel performed battery reclaiming. Runoff from stored sludges from the reclaiming operation was transported down a drainageway and reached a cutoff oxbow of the Rib River. The primary contaminant in the oxbow sediments was lead. The oxbow lake is approximately four acres and consists of soft sediments contaminated with lead to a depth of two feet. High-end lead levels in the sediment ranged from 540 to 850 mg/kg. Based on a number of considerations made during the feasibility study, capping of the site was chosen as the remedy. In February 1977, a cap consisting of geotextile and a one-foot sand blanket were placed on top of the ice over the area. During spring ice-out, the capping material settled onto the bottom. At locations out from the shoreline around the perimeter, habitat islands were created by placement of another layer of geotextile on top of the sand cap and rock rubble placed over this. During post-capping monitoring in the summer of 1999, the overall assessment was that a good quality aquatic habitat was developing in the capped oxbow area. There were a number of beds of emergent and submergent plants starting. A number of schools of young fish were observed. Observations indicated there may be a need to address nonpoint runoff to the oxbow and tributary inputs to the oxbow to maintain the quality of the habitat created and to look at some aspects of cap maintenance.

This sand/geotextile, placed over ice, will later settle over the bottom to isolate contaminated sediments.

Bay Shipbuilding

This site is located in the Sturgeon Bay Ship Canal between Green Bay and Lake Michigan. Bay Shipbuilding operates a ship refurbishing facility, which includes sandblasting and painting the surfaces of ships. The WDNR began pursuing Bay Shipbuilding in early 1990 for a number of hazardous waste violations. Subsequent site investigations identified the sediments associated with berth 11, in which sandblasting and painting in a floating dry-dock occurred, were contaminated with levels of zinc and lead as high as 1,700 mg/kg and 400 mg/kg, respectively. Other metals (copper and nickel) were also elevated in the sediments. Bay Shipbuilding undertook a removal action for the contaminated unconsolidated, soft sediments in June 1997. The target cleanup level for lead was 50 mg/kg. The overlying sediments were removed down to the more consolidated underlying parent materials. A total of about 6,000 cubic yards of sediment was removed. Concurrent actions addressed contaminated soils associated with the facility and eliminated any possible on-land sources of contamination to the adjacent waterway.

Fountain City Service Base

This site is located on the Mississippi River at Pool 5a. The U.S. Army Corps of Engineers (ACOE) service base, both on-land and in the adjacent river sediments, was contaminated with polychlorinated biphenyls (PCBs). The highest sediment PCB concentrations were 5 mg/kg and on-land soils contained 50 mg/kg. The area of PCB contaminated sediments extended off shore from a boat launch ramp in an area approximately 100 x 200 feet. The ACOE dredged this area to remove the contaminated sediments in March 1999. The cleanup goal for the PCBs in the sediments was 0.8 mg/kg. The ACOE construction report for the removal has not been completed.

Ansul Incorporated

Ansul Incorporated is located in Marinette on the Menominee River. Ansul manufactured organic arsenical herbicides from 1957 to 1977. Onshore storage of wastes in a salt vault area led to the contamination of groundwater, the adjacent Eighth Street boat slip, the Turning Basin of the navigational channel, the Menominee River, and Green Bay. Corrective actions at the site are being done under the Resource Conservation and Recovery Act (RCRA) with U.S. EPA on the lead. An Interim Measures Agreement under a consent decree requires Ansul to address the site contamination in various phases. The contaminated groundwater under the former Salt Vault area and the Eighth Street Slip were to be isolated to the extent practical to prevent any more migration and discharge of the contaminated groundwater to the river. The attempted isolation was accomplished by the installation of a sheet pile barrier around the Eighth Street slip and Salt Vault area in October 1998 to January 1999. The sheet pile barrier was driven to the depth of bedrock, which was approximately 40 feet. A slurry wall barrier was installed along the west and south sides of the former salt vault area.

Also as part of the Interim Measures Agreement, Ansul dredged the arsenic contaminated unconsolidated sediments out of the Eighth Street slip in June to August 1999. Approximately 12,400 cubic yards of sediment were removed. Further phases of the Interim Measures agreement require Ansul to address the arsenic contaminated subsoil in the Eighth Street slip, and the contaminated sediments and subsoils in the Turning Basin and Menominee River.

Oil-contaminated sediments were removed after the Newton Creek impoundment was drawn down.

Contaminated sediments from the Newton Creek impoundment are being disposed in a landfill.

Murphy Oil Refinery

Murphy Oil Refinery is located in Superior on Newton Creek, a tributary to Superior Harbor. Investigations by WDNR in 1993 and 1994 showed that the 1.5-mile length of Newton Creek and Hog Island Inlet into which Newton Creek flows was contaminated by petroleum-related residues. A memorandum of Understanding was reached between WDNR and Murphy Oil in which Murphy Oil agreed to remediate the impoundment at the creek's headwaters that receives their wastewater discharge and the first segment of the creek below the impoundment. In 1997, Murphy Oil removed approximately 4,200 cubic yards of contaminated sediment from the impoundment and approximately 700 feet of the creek. The agreement also called for studies to be conducted along the creek over a five-year period to determine the effects of the remediation on the downstream waters and continued presence of petroleum residues in the creek sediments. The Remediation and Redevelopment Program is conducting assessments on downstream segments and the hydrocarbon content in Murphy Oil's wastewater discharge.

Baraboo Manufactured Gas Plant Site

This site is located on the Baraboo River in south central Wisconsin. Removal of three dams along the Baraboo River is part of the Baraboo River Restoration Project. Planed removal of the dams will lead to restoration of the river corridor by improving aquatic and terrestrial habitat, recreational opportunities, biodiversity, and water quality. It will also remove impediments to fish migration. In late 1998, while WDNR staff was conducting benthic surveys in an area above the dam, they encountered coal tars in the sediments. Removal of the Oak Street Dam that was planned for early 1999 was postponed until the extent of the contamination could be determined. The utility that was responsible for the adjacent onshore former manufactured gas plant was requested to perform a site investigation of the river sediments to determine the degree and extent of the coal tar contamination. Based on the investigation, the utility proposed to remove the contaminated sediments from the river. A sheet pile barrier was placed around the boundaries of the contaminated sediments in the river. After the barrier was installed, the dam was breached to lower water levels. The contaminated sediment was then excavated from the sheet pile area. Approximately 4,400 cubic yards of sediment were removed. Sediment was excavated down to clean underlying subsoils. The remediation was completed in February 1999. The sheet pile barrier was removed and the bank restored and riprapped. Vegetation will be planted in the area this spring. Related activities involved sloping of the opposite bank and preparation for a walkway along the river to be constructed by the city.

Fox River - Deposit N

Deposit N is located on the Lower Fox River near Little Chute and Kimberly. The WDNR and U.S. EPA sponsored a PCB contaminated sediment removal demonstration project from the Fox River at sediment Deposit N in 1998-99. This project was successful in meeting the primary objective of the demonstration project, that environmental dredging of PCB contaminated sediment can be performed in an environmentally safe manner. Other benefits of the project were public outreach and education on environmental dredging.

Deposit N covered an area of approximately three acres and contained about 11,000 cubic yards of sediment. PCB concentrations were as high as 186 parts per million (ppm). The sediment deposit averaged 2-3 feet thick over fractured bedrock in water depths of about eight feet.

Of the 11,000 cubic yards in Deposit N, about 65% of the volume were designed for removal down to bedrock conditions. Approximately 8,200 cubic yards of sediment was removed generating 6,500 tons of dewatered sediment, containing 112 total pounds of PCBs. Of the total sediment volume removed during the entire project, about 1,000 cubic yards was obtained from Deposit O, another contaminated sediment deposit adjacent to Deposit N. Monitoring data showed that the river was protected during the dredging and that wastewater discharged back to the river complied with all permit conditions. The project met the design removal specifications (i.e., sediment volume, tonnage, allowed residual thickness).

Results of the project showed public acceptance for environmental dredging to remediate PCB contaminated sediment. Permit conditions can be met and the work can be performed without harm to the river, river uses or local communities.

This hydraulic cutterhead dredge was used to clean up Fox River - Deposit N of PCB contaminated sediment.

Fox River – Deposits 56 & 57

Deposits 56 and 57 are located on the Lower Fox River about three miles from the mouth of the river. The Fox River Group, a coalition of seven parties on the Lower Fox River formed for PCB contamination, performed a pilot sediment remediation project on the river in 1999. The project removed approximately 30,000 cubic yards of PCB contaminated sediments with concentrations up to 710 ppm. Although the project was designed to remove as much as 80,000 cubic yards of sediment, work was suspended in late 1999 due to winter weather conditions. Evaluation of the project results is still ongoing. However, preliminary data indicate the project has been very successful in demonstrating that the long-term river restoration goals can be attained as proposed in the draft Lower Fox River Remedial Investigation and Feasibility Study(RI/FS).

Initial data indicates several significant results including:

- The project was designed and conducted so that dredging of the contaminated sediment could be done in an environmentally safe way.
- Where the dredging was completed to the design depth, the level of cleanup proposed in the RI/FS could be attained.
- Where the dredging was begun but not completed, due to weather conditions and other problems, higher concentrations of PCBs have been exposed and could be further distributed downstream.
- Any PCBs released into the air during the project were not detectable away from the site and reached only very low levels at the dredging site.

North Avenue Dam

The North Avenue Dam is located on the Milwaukee River about 3.2 miles upstream from the river's confluence with Lake Michigan. The North Avenue Dam was constructed over 150 years ago and creates an artificial boundary between the 80-acre Milwaukee River impoundment and the Milwaukee River Estuary. The sediments in the impoundment are contaminated with PCBs, PAHs and heavy metals. This remediation project is a voluntary action funded by the state of Wisconsin, City of Milwaukee, Milwaukee County and U.S. EPA. The goal is to restore the environment and remove the contaminated sediments.

Site construction was started in August 1997 with the dam being removed at the end of 1997. The majority of the remediation work involved mechanical dredging of 8,000 cubic yards of sediment. The remaining 742,000 cubic yards of sediment will be managed in place. The concentration of PCBs ranged from <5-29 mg/kg with an average of 3.3 mg/kg.

The remainder of the work consists of fish habitat restoration, stream bank protection (using a combination riprap, articulated concrete matting and bioengineered systems), upland plantings and wetland restoration. These activities were finished during the spring of 1998. The total cost for all phases of the project – dam abandonment, water intake replacement, sediment management and habitat restoration activities—was approximately $4.7 million.

Pending Contaminated Sediment Sites

There are a number of contaminated sediment sites where remediation is pending based on current negotiations, discussions, and/or enforcement actions. Those sites are described below.

Hayton Millpond

Hayton Millpond is located in Calmet County near the Village of New Holstein. In the early 1990s, the WDNR found PCBs in Hayton Millpond and more than six miles upstream between the Village of New Holstein and the Millpond. The Killsnake Wildlife Area is immediately downstream of the millpond. Presently the WDNR and Tecumseh Products Company, working on a voluntary basis, have developed a remediation plan for the "source area" just north of the village. The PCB concentrations in the source area range from less than one mg/kg to 2,500 mg/kg.

As a first phase of this plan scheduled for 2000, all sediment with PCB concentrations of more than 50 mg/kg will be removed. The sediments will be properly disposed at a cost of about $700,000, with partial funding from the U.S. EPA Great Lakes National Program Office. Removal of additional PCB contaminated sediments in the source area is anticipated for 2001. Remediation plans for the downstream areas will likely be completed in 2001 or 2002. Issues that need to be resolved for the downstream areas include whether to remove sediment in major deposition areas along Pine Creek or construct a new channel to replace about four miles of natural stream channel. Another difficult issue is when and whether to remove the dam at Hayton.

Sheboygan River

U.S. EPA designated the harbor and lower fourteen miles of the Sheboygan River, a tributary to Lake Michigan, as a Superfund Site in 1985. Tecumseh Products Company is a potentially responsible party because its plant in Sheboygan Falls was discovered in 1978 to be a source of PCB contamination in the river. From 1989-1991, approximately 5,000 cubic yards of sediments contaminated with PCBs were removed from the river by Tecumseh's consultants and contractors under a Pilot Study and an Emergency Removal Order. About 3,500 cubic yards of the PCB-contaminated sediments were placed in a confined treatment facility on Tecumseh Products Company grounds for further experiments and tests. The other 1,500

cubic yards were placed in a temporary storage facility on site. All 5,000 cubic yards will be handled for final remediation in the Record of Decision for the site. An "Alternative Specific Remedial Investigation" report on the pilot study activities and a "Feasibility Study" report considering various remedies for the site were prepared by Tecumseh and their consultants in 1995 and 1998, respectively. The National Oceanic and Atmospheric Administration (NOAA) and consultants, with the final report available in November 1998, conducted an Ecological Risk Assessment in 1997. U.S. EPA released their "Proposed Plan for Cleanup of the Sheboygan and Harbor Superfund Site" in May 1999. A Record of Decision for the Site is expected during 2000.

Moss-American Wood Treatment Site

This site is located on the Little Menomonee River in Milwaukee. The plant operated from 1921 until the mid-1970s on a 23-acre site. The plant was a creosoting facility where railroad ties and other wood products were treated and stored. The creosoting process used at the plant consisted of impregnating wood products with a mixture of 50% Number 6 fuel oil and 50% coal-based creosote. The Moss-American facility is the responsibility of Kerr-McKee Corporation. The plant operations contaminated site soils, groundwater, and a five-mile reach of the Little Menomonee River from the plant site down to its juncture with the Menomonee River. Creosote/fuel oil contamination may have been transported beyond the juncture and to downstream areas of the Menomonee River and the Milwaukee Estuary. Moss-American is a U.S. EPA lead Superfund site. U.S. EPA placed the site on the National Priority List of hazardous waste sites in 1983. A Record of Decision (ROD) for the site was signed in September 1990. The ROD called for the design and excavation of an alternative channel that would parallel the existing contaminated river channel. Remediation of site soils and groundwater have proceeded for the site based on the ROD. However, U.S. EPA has chosen not to have the channel alternative in the ROD implemented to date because of perceived impacts to the associated wetland areas. The agencies have since been involved in unsuccessful negotiations with the responsible party in regard to the design aspects of remediating the contaminated sediments in the existing channel. Pending the submission of the responsible party's proposed designs for remediating the existing channel, U.S. EPA will make a decision whether to accept the proposals or to require the implementation of the original ROD remedy of the alternative channel in the near future.

Fraser Shipyards

Fraser Shipyards is located in Superior on the St. Louis River at Howard's Pocket. Fraser Shipyards paints and refurbishes ships. The facility has been pursued under the Resource Conservation and Recovery Act (RCRA) authority for contaminated areas on the plant property. Contaminated sediments have been found next to the dry docks of the facility and out into Howard's Pocket. On land contamination has been addressed through corrective measure actions. Contaminated sediments remain to be addressed. Initial information indicates metal contamination in the sediments, principally lead, and possibly oils. Site investigations for degree and extent of the sediment contamination are needed. When data is available, the need for further actions will be determined.

Penta Wood Products

Penta Wood Products is located in Siren in the St. Croix River Watershed. The Penta Wood Products (PWP) site consisted of 80 acres and operated from 1953 to 1992. Posts and telephone poles were treated with either a 5-7 % pentacholorophenol solution in a Number 2 fuel oil carrier, or with a water borne salt treatment called chemonite, consisting of amonia, copper, arsenic and zinc. During 39 years of operation, PWP discharged wastewater from an oil/water separator down a gully to a lagoon on the northeast corner of the property. Plant operations caused extensive contamination of site soils and groundwater. An area of wetland soils down-gradient and on the edge of the property was found to be contaminated with PCP,

arsenic and copper during the investigations. The area is a U.S. EPA lead Superfund site. State and federal funding is in place and remedial actions for the site are to be initiated later this year. This site went from placement on the National Priorities List to remedial action in approximately six years.

Eau Claire POTW Former Discharge Site

This site is located in Eau Claire on the Chippewa River. Sediments in the area around the former effluent discharge point from the Publicly Owned Treatment Works (POTW) have been found to be contaminated principally by metals including chromium, copper, lead, mercury and zinc and low levels of Polychlorinated Biphenyls (PCBs) and Polycyclic Aromatic Hydrocarbons (PAHs). Discussions with the city will be initiated to remdiate the area of contaminated sediments.

Sediment Sites Undergoing Investigation

These are sediment sites that are or have undergone site investigations to determine the degree and extent of contamination.

Koppers Industries, Inc.

Koppers Industries, Inc. is located on Crawford Creek in Superior. The facility treated wood with pentachlorophenol and creosote. Koppers Industries is under the Resource Conservation and Recovery Act (RCRA) program and has undertaken corrective measures studies related to the soil and groundwater contamination at the site. Past discharge practices have contaminated the sediments and overflow areas along a drainage ditch from the facility as well as Crawford Creek. Crawford Creek is a tributary of the Nemadji River that flows into Superior Bay. It appears an extensive flood plain area in Crawford Creek (approximately one mile downstream of the plant) is extensively contaminated with creosote residues. Downstream beaver dams may have backed up flows at various times when the creek was carrying creosote loads. This has lead to an expansion of the floodplain in areas upstream of a railroad grade. A consultant for the former owners of the facility has conducted studies to determine the degree and extent of contamination and also conducted a preliminary ecological risk assessment. The WDNR awaits submission of the studies for review and determination of further actions.

Lower portions of Crawfish Creek and the floodplain soils are extensively contaminated with creosote.

Gruber's Grove Bay

Gruber's Grove Bay is approximately 20 acres in size and located on the Wisconsin River at the south end of the Badger Army Ammunition Plant near Baraboo. Initial sampling in the bay by WDNR and the Army in 1999 found elevated levels of mercury, methyl mercury, lead, copper, chromium, and nickel in the sediments. The drainage into the bay is located near a series of former wastewater treatment ponds on the plant property. In February 2000, a consultant for the Army undertook the initial effort of a two phased approach to determine the degree and extent of metal contamination in the sediments. Phase 2 of the investigation

was designed, like Phase 1, to sample the sediments through the ice. However, above normal temperatures in late February apparently made conditions unfeasible to complete the sampling. When sampling is completed and reports submitted for review, the WDNR would assess the need for further actions.

DuPont Barksdale Plant

The DuPont Barksdale plant is located on Boyd Creek on Lake Superior. The Barksdale plant manufactured trinitrotoluene (TNT) from 1904 to 1971 and was located between Ashland and Bayfield. The consultant for DuPont recently submitted a water and sediment sampling report from Boyd Creek for a number of nitroaromatic compounds associated with the manufactured TNT or its breakdown products and other parameters. An initial review of the data indicates low level detects of some of the nitroaromatic compounds in the water and sediments of the creek, all of which are at concentrations below potential toxic levels to aquatic life. Conductivity levels increase downstream which may be a reflection of the ionic-related components (sulfates, nitrates, ammonium) from the product or product components. These components may be originating from the site sediments, site soils, or groundwater. It is unknown what impact the elevated conductivities may have on the biota of the creek. Decisions are to be made about the need for further actions. Natural attenuation may be the most feasible alternative given the diffuse nature of the contamination.

City of Rhinelander Landfill

The City of Rhinelander landfill is located near Slaughterhouse Creek and the Pelican River in Oneida County. The city is under enforcement action to address the movement of contaminated groundwater from the landfill to adjacent Slaughterhouse Creek and the Pelican River. The city has placed a new cap on the landfill and installed a groundwater pump and treatment system on the Pelican River side of the landfill. To address the Slaughterhouse Creek side of the landfill, the city's consultant is attempting phytoremediation which involves planting willows and poplars on the slope of the landfill cap.

Earlier investigations by WDNR have found contaminated sediments in Slaughterhouse Creek and also impaired water quality conditions (elevated levels of ammonia, hardness, conductivity) due to the landfill. Monitoring has focused on the temporal and spatial changes in the water quality parameters and performing toxicity identification studies. Further sediment assessment work may be done this season to identify the degree and extent of contamination. Based on findings related to the water quality studies and any further sediment investigations, determinations will be made for further actions.

Hydrite Chemical Company

Hydrite Chemical Company is located on Koshkonong Creek in Cottage Grove. This facility is a solvent recycler that has contaminated the groundwater with organic compounds (VOCs). Based on enforcement actions, the sediments and surface waters that are downgradient have been sampled by the company to determine the degree and extent of VOC contamination. The waterbodies immediately impacted are a large man-made pond associated with a subdivision development and the drainageway from the pond that flows through a potential wildlife development area. To date, monitoring has found low levels of detection for several VOC compounds in the sediment and water. None of the concentration levels are presently of concern in terms of risks of exposure to humans, wildlife or aquatic life.

Fort James Paper Mill

Fort James Paper Mill is located in Ashland on Chequamegon Bay on Lake Superior. The Fort James Paper Mill in Ashland was a deinking tissue mill that manufactured industrial napkins with waste paperboard from 1902-1998. Treated wastewater was discharged to Chequamegon Bay. After plant closure in 1998, sediments in the bay were sampled to determine if there was any residual contamination related to historical plant discharges. For

(above) Capping of contaminated wetland soils helps eliminate wildlife exposures to contaminents.
(right) Followup monitoring after capping is important in determining if ecological risks remain.

metals and PAHs, all the concentrations appear reflective of unimpacted sand substrate in near shore areas. No guideline concentration values are exceeded. For 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and substituted dioxin and furan congeners, no 2,3,7,8-TCDD was detected, but elevated levels of 2,3,7,8-substituted hepta- and octachlorinated dioxin and furan congeners were found. The concentration level of these compounds fit the fingerprint of waste discharges from a deinking tissue mill that recycled waste paperboard. The environmental significance of the higher chlorinated 2,3,7,8-substituted forms is less than the 2,3,7,8-TCDD form for a number of reasons including lower toxicity and bioavailability when associated with the sediments. Based on the information available, the levels of the substituted forms of dioxin and furan do not represent any significant risks to humans, wildlife, or aquatic life.

C.R. Reiss Coal Dock

C.R. Reiss Coal Dock is located in Ashland on the Chequamegon Harbor of Lake Superior. The coal dock in the harbor has been present for a number of years. Sediment sampling was conducted to determine the presence of contaminants and particulates in the harbor related to coal pile storage. A general concern for all Wisconsin's Areas of Concern was the potential source of contaminants from coal storage piles in harbors because of resulting stormwater runoff and leachate and from wind blown particulates. At one large storage site, it was estimated that 20 metric tons of coal particulates were carried from the piles by the wind and deposited over the associated harbor and estuary area. Sediment sampling results near the C.R. Reiss Dock in Ashland showed elevated levels of copper, lead, mercury, zinc, and PAHs. Coal fines and particulates were observed in the samples. Based on the findings, the WDNR is assessing the need for further actions.

Horicon Marsh Wildlife Area

The Horicon Marsh Wildlife Area is part of the Rock River and is located in south central Wisconsin. Based on existing sediment sampling data for the Rock River and Horicon Marsh, sediment quality was assessed in relationship to the Wisconsin Whooping Crane Breeding site assessment. A joint Canadian-United States Whooping Crane Recovery Team assessed several wetland areas in Wisconsin for their potential to be used for nesting sites in order to re-establish whooping cranes in Wisconsin. One of the habitat components examined the sediment quality to determine if contaminant levels would pose a problem for the food chain of the whooping cranes. The conclusion was that there was low toxicological risk via food chain exposure based on the levels of metals found in the marsh sediments.

Bay Port Dredging Facility

This facility is located in Green Bay. The Port of Green Bay wanted to expand the Bay Port Dredge Material Disposal Facility. Historically the U.S. Army Corps of Engineers (ACOE) hires a contractor to perform the dredging of the shipping channel and operate the disposal facility as part of an annual dredging contract. Brown County is responsible for providing the disposal facility. The ACOE dredges approximately 150,000 cubic yards of sediment annually to maintain the 18-mile long shipping channel in the Fox River at depths of 22 – 26 feet. A key issue was whether the wetland habitat, developed from the disposal facility, should be preserved because of their use by a state endangered plant species (Seaside Crowfoot) and several endangered or threatened water birds (Great Egret, Snowy Egret, and Black-Crowned Night Heron). Based on an assessment of the quality of dredged sediments in the wetland-created disposal area, the recommendation was made to allow the expansion of the disposal facility. The wetland soils contained elevated levels of metals, PCBs, and PAHs that represented a high degree of ecological risks to the wetlands aquatic life and wildlife. By allowing the expansion, cleaner sediment would be placed over the contaminated wetland soils isolating them from further exposure to wildlife, and reducing or eliminating future risks.

Other Sediment Projects

There is several other sediment sampling or assessment related dredging projects ongoing:

- Rib Lake Log Removal, Taylor County;
- Harbor Town Marina Dredging Project, Menekaunee Harbor, Menominee River, Marinette;
- Castle Rock and Petenwell Flowages, Wisconsin River;
- Franklin Impoundment, Sheboygan River;
- Lake Alice, Wisconsin River, Wausau;
- Rice Lake Landfill, Rice Lake;
- Frame Park, Fox River (IL.);
- Dunn County Apple Orchard, Knight's Creek;
- Kewaunee Marsh Ecological Risk Assessment for the arsenic spill;
- Ashland Coal Gas Site, Ashland;
- Crandon Mine Wetland Soil Assessment, Forest County; and
- Oconto River dredging project related to habitat restoration.

Contaminated Sediments at Coal Gas Plants

Some surface waters associated with former manufactured coal gas plants have contaminated sediments. Manufactured gas plants (MGPS) or town gas plants were present in many communities and operated from the mid-1800s through, in some cases, the 1960s. Prior to natural gas, the MGP produced gas for home lighting, heating and cooking. The feedstocks for producing gas was predominantly coal. The waste by-products and contaminants were potentially released to surface waters from MGP operations. It depended on the feedstocks that were originally used (oil or gas) and the primary MGP processes: coal carbonization,

water gas, or carbureted water gas. A plant may have used more than one process over its operating life. Waste by-products included coal tars, tar sludges, oil tars, tar/oil/water emulsions, lampblack, ashes, cinders, coke, spent lime, spent oxides, cyanide in purifier box residuals, and solid wastes from retort bricks. These contaminants may have been released from the process of gas production, gas cleanup, tar and hydrocarbon processing. The plants generally operated in relatively confined areas and generated a number of types of wastes in a period when waste disposal was not subject to state, federal, or local regulations. The nearest convenient disposal outlet, which included surface waters, may have been used. Depending on the plant and location, some waste by-products, such as coal tars, were re-sold for other uses. Depending on the manufacturing process and waste by-products, direct discharges to surface waters, or from contaminated groundwater input, could have resulted in sediment contamination from complex mixtures of organic compounds. Some of those compounds could have included polycyclic aromatic hydrocarbons, heterocyclic aromatic compounds (nitrogen, oxygen, hydrogen), volatile organic compounds (benzene, ethylbenzene, toluene, and xylene), phenolic compounds, metals, cyanide, inorganics (ammonia, nitrates, sulfates, sulfide), oil and grease, and oxygen demanding wastes. These compounds, either singularly or in combination, can cause chronic or acute toxicity to aquatic organisms. A significant finding is that some sites, even 50 years after the plants ceased operations, still have coal tars in surficial sediments largely as a free product. The intervening years have not led to attenuation or burial of the coal tar materials.

Beginning in the late 1980s, the WDNR began compiling a list of former MGP sites and requesting that current owners (utilities) perform site investigations to determine the extent of soil and groundwater contamination associated with former plant locations. More current requests to the utilities have asked them to include more extensive sediment investigations based on earlier findings at some sites. There are approximately 50 former MGP locations around the state. The sediment information/activities at these sites varies from:

- Little or no information available about the location or history of the plant in the community,
- Ongoing investigations by utilities,
- Investigation reports that have found no sediment contamination,
- Investigation reports that been produced and are being reviewed,
- Feasibility studies have been conducted for remediation,
- Pilot testing of in situ remediation of sediments has been conducted, or
- Remediation has been completed.

The WDNR has formed a Manufactured Coal Gas Technical Team. It is made up of regional site project managers and water program staff that coordinate and review the technical issues such as investigating and remediating former MGP sites, including contaminated sediments and surface waters. Guidance has been prepared for investigating the sediment and surface water component of coal gas sites. Attempts have been made to coordinate the investigation and cleanup activities for multiple statewide sites where one utility is responsible for the sites. Table 7 provides a list of investigated sites that have been identified as having, or not having, contaminated sediments or surface waters associated with them. Table 7 also lists the name of the surface water and the WDNR Region, and the status of the site investigation or sediment remediation. The WDNR's Remediation and Redevelopment Program, through agreements with the responsible utilities involved, are currently addressing all sites. The Ashland MGP site has been scored by U.S. EPA for listing on the Superfund National Priorities List based on a petition from local entities.

Table 7. List of sites investigated for Contaminated Sediments and their Status.

MGP City	Water Body / Region	Status of Site Investigation - Sediments	
Ashland	Lake Superior - NOR	Site investigation and feasibility study completed. Department awaits outcome of EPA scoring and listing of the site on NPL	One utility responsible for the four sites.
Chippewa Falls	Chippewa River – WCR	Site investigation indicates near shore contamination, but no sediment contamination	
Eau Claire	Chippewa River – WCR	Site investigation underway	
La Crosse	Mississippi River – WCR	Site investigation underway	
Green Bay	Lower Fox River – NER	Site investigation completed	One utility responsible for all 6 sites. Discussions with utility left off with utility to address at least one site per year for remediation. Dept. will review priority of sites to be addressed.
Oshkosh	Lower Fox River – NER	Site investigation completed	
Marinette	Menominee River – NER	Site investigation completed.	
Two Rivers	West Twin River – NER	Site investigation completed	
Sheboygan I and II	Sheboygan River – SER	Site investigation completed	
Stevens Point	Wisconsin River – WCR	Sediment investigation report due	
Appleton	Lower Fox River – NER	Site investigation completed. Minimal coal tar contamination under nearshore rubble. Fast currents in stream stretch made deposition in channel unlikely if it occurred.	Both sites the responsibility of one utility
Burlington	Fox River- IL. – SER	Site investigation included coring in river sediments.	
Manitowoc	Manitowoc River – NER	Pilot testing using MEC TOOL mixing and solidification of river sediments unsuccessful. Further discussions with utility as to next steps needed.	
Baraboo	Baraboo River – SCR	Remediation of coal tar contaminated sediments completed in February of 2000. Sheet pile placed around contaminated area and dewatered in association with downstream dam removal prior to excavation. Shore area to be riprapped and vegetated as part of river walk creation.	
Beaver Dam	Beaver Dam River – SCR	Site investigations indicate that sediments or surface waters	
Fort Atkinson	Rock River – SCR	generally not involved	
Janesville	Rock River – SCR		
Madison	Lake Monona – SCR		

1. NOR - Nothern Region
2. WCR - West Central Region
3. SCR - South Central Region
4. SER - Southeastern Region
5. NER - Northeastern Region

Sediment Monitoring

Sediment monitoring is conducted as part of baseline condition monitoring or for special projects in order to: 1) investigate areas with contaminants associated with pollutant sources, 2) investigate areas of fish advisories, 3) establish reference/background concentrations of metals and organic compounds through various sampling efforts, 4) determine pre-dam removal assessments or other stream disturbance assessments, and 5) assess contaminated sediment sites.

During the reporting period from 1996 through 1999, approximately 600 sediment samples were tested for the presence of contaminants. The majority was analyzed for PCBs, PAHs, other chlor-organic toxicants, plus numerous metals. Of those samples, a number were also tested for acute and chronic toxicity. The sites where sediments were monitored for acute and chronic toxicity over the last four years included: Apple Creek, Ashwaubenon Creek, Baraboo River, Beaver Dam Creek, Belgium Creek, Big Rib River, Black River, Bugle Lake, Buffalo Lake, Cedar Creek, Chippewa River, Dutchman Creek, Fowler Lake, Fox River, Garners Creek, Green Bay, Hale Creek, Hemlock Creek, Honey Creek, Kankapot Creek, Kenosha Harbor, Kewaunee River, Koshkonong Creek, Lake Geneva, Lincoln Creek, Little Menomonee River, Little Oconomowoc River, Little Rib River, Manitowoc River, Milwaukee River, Mississippi River, Mud Creek, Mullet River, Muskego Lake, Oak Creek, Oconomowoc River, Oconto River, Onion River, Pelican River, Pike River, Plum Creek, Prairie River, Racine Harbor, Rib Lake, Rock River, Root River, Rubicon River, Shawano Lake, Sheboygan River, Slaughterhouse Creek, Spring Brook, St. Croix River, Trempealeau River, Wacdale Creek, Wisconsin River, and Wolf River.

Sediment Mapping

Sediment mapping continues to be an integral part of Wisconsin's contaminated sediment program. Since 1996, the WDNR sediment mapping techniques have improved in both efficiency and data analysis with the increased use of Global Positioning Systems technology and multiple levels of GIS integration. By using proven field techniques and sound analytical methods, spatial and temporal components of contaminated sediment occurrence and transport can be identified. Subsequently, sampling, planning and site management efforts are greatly refined.

Recent sediment mapping has played a key role in defining pre-dredge riverbed characteristics at the Deposit N Demonstration Project on the Fox River. Sediment mapping has also been used to aid in site-assessment for removal of the Franklin Millpond Dam, which is located on the Sheboygan River in Sheboygan County. In addition, sediment-mapping techniques have proven useful to WDNR researchers conducting sediment-compaction studies on Fox Lake.

WDNR are currently investigating techniques to document the behavior of site-specific sediment bed dynamics in response to varying flow regimes.

Water Resources Management

Historically, water resource management was narrowly focused. Limited interaction occurred between programs that addressed different aspects of the ecosystem. Project-specific, short-term management also prevailed. The WDNR approach has shifted from a single issue focuses to ecosystem management. The WDNR is integrating many of its programs and bringing together multiple agencies, interests and jurisdictions into a "watershed approach," which addresses all parts of the ecosystem. To achieve ecosystem management, the WDNR has reconfigured its organizational structure to more closely mimic the natural features of the landscape.

Department Reorganization

During the WDNR recent reorganization (1995-98), several changes were instituted. These changes reflect the theme of public participation and partnership, a shift toward implementing an ecosystem or watershed approach, and the need to achieve cost-effective program management. Resource management and protection was better linked to the ecosystem by realigning the regional structure along geographic management units (GMUs) and by strengthening management leadership at the field level. Instituting a team approach to program development enhanced integration and public participation. This was done both internally and externally to encourage multiple perspectives in decision-making. The approach is now tied to ecoregions and drainage basins (natural constructs) with basin or GMU teams applying a watershed approach to management.

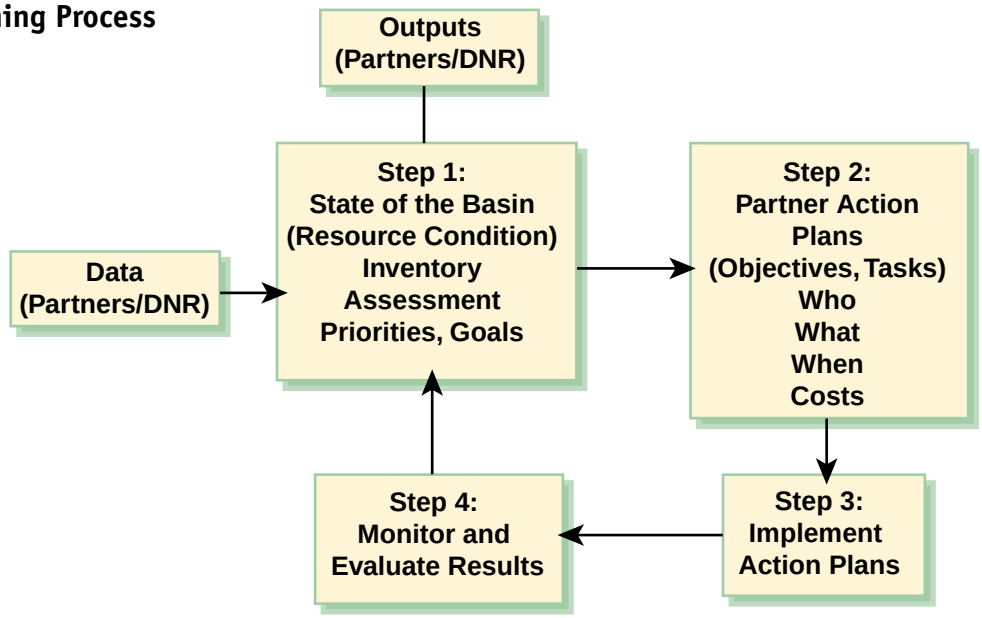
Integrated Planning

WDNR changes are directly reflected in the way the water quality is managed. Regional management teams in each geographic management unit (GMU) are responsible for developing State of the Basin reports through an integrated planning process. This multi-step process involves utilizing the strengths of the GMUs external partnership teams to identify and manage all aspects of the ecosystem (refer to Figure 5). Each GMU, over the current biennium, will work with their partnership team to identify a vision for the GMU's ecosystem, the existing resource conditions, and impediments to achieving optimum resource health. The resource inventory will take into account WDNR data and other available information on water and land resources to develop an accurate ecosystem assessment for each GMU.

Planning efforts with partner groups will result in a document that provides a snapshot of ecological conditions, management needs and priorities within each basin or GMU. This effort will also be the basis for work planning and budget decisions in the various program areas (fish, wildlife, and water quality) over three biennia. These plans are also intended to satisfy requirements of Section 208 of the Clean Water Act.

The plans will 1) highlight priorities identified by the partner group process; 2) provide a concise but descriptive summary of the physical and biological characteristics of the basin, including summary data; 3) identify GMU-specific water, fishery, wildlife and habitat issues; and 4) identify basin-specific objectives (in the form of recommended actions) linked to the GMU-specific issues. GMU objectives will form the basis for future work plans and project and budget requests.

Figure 5. Integrated Planning Process



Basin Planning Efforts from 1996-2000

Integrated planning will continue the state's tradition of identifying resource issues in basin plans. However, work conducted up to the current reporting year highlights several recurring resource issues. The primary issues for streams continue to be degraded habitat and polluted runoff. For lakes, it is mercury contamination from airborne pollutants, polluted runoff, and hydrologic modifications and shoreline development. For the Great Lakes the issues are fish consumption advisories, toxicants, runoff and habitat loss. For wetlands, it is development, and for groundwater, the issues are contaminants from agricultural activities and storage and spills of materials.

WDNR continues to make progress toward increasing the number of surface waters assessed for their water quality condition. This effort will be enhanced in the next year by WDNR's new monitoring program and the integrated planning process. In the past, basin plans have been updated every five years. These plans have summarized the condition of the waters in each river basin, identified improvements and specific management and monitoring needs, and made recommendations for cleanup or protection. All plans generally address lakes, streams, and groundwater and pollutant discharge issues and may include wetland discussions when there are specific issues. The basin plans have identified specific high priority areas including nonpoint source runoff and wastewater discharges as well as work planning goals and monitoring recommendations.

Wisconsin's 32 river basins fall into 23 management units designated by state codes, for which water quality management plans have been developed. These management units are further rearranged to create 23 planning units (Figure 6). U.S. EPA has acknowledged Wisconsin's water quality management plans as unmatched in this region, and the program continues to evolve and build on its success. WDNR continues to invest resources in the Geographic Information System (GIS) and other computer-aided means of data collection and interpretation.

During the last reporting period, the planning process continued to evolve and adapt the successes of the state's water quality program to fit the new GMU implementation structure. Upcoming changes also include improvements in criteria used to assess and rank stream and lake water quality in the plans and in data collection and consistency.

Figure 6. Wisconsin Department of Natural Resources Geographic Management Units (GMU)

Between 1996 –2000, the Bureau of Watershed Management (formerly Water Resources Management) updated and published eight water quality management plans, several amendments to updated plans, and began development of the State of the Basin reports for all GMUs simultaneously (statewide) to be completed by July 2001. Plans completed over the last four years include the Wolf River Basin, the Manitowoc River Basin, the Lake Superior Basin, the Upper Wisconsin Northern Sub-Basin, the Lower Rock River Basin, the Buffalo-Trempealeau Rivers Basin, the Lower Fox River Basin, the Sheboygan River Basin, and the Lower Chippewa. Plans started, but not completed, include the Grant-Platte Rivers Basin (internal review draft), the Black River Basin (public review draft), and the Upper Green Bay Basin. These plans will be rolled over and used in the upcoming integrated planning process as a starting point for the State of the Basin reports.

Table 8 summarizes the status of the basin planning efforts in Wisconsin.

Table 8. The status of the basin planning efforts in Wisconsin.

Existing Basin Plans	Published	Comments
SUPERIOR - NOR	1999 (299)	
SHEBOYGAN - SER	1999 (209)	
LOWER ROCK - SOD & SED	1998 (264)	
UPPER WI NORTH - NOR	1997 (322)	
MANITOWOC - NER	1997 (162)	
UPPER CHIPPEWA-NOR	1996 (350)	
WOLF – NER & NOR	1996 (300)	
LOWER CHIPPEWA - WCR & NOR	1996 (293)	
BUFFALO-TREMPEALAU – WCR	1996 (131)	
SUGAR PECATONICA – SER	1995 (185)	
UPPER ROCK - SER	1995 (153)	
TWIN DOOR KEWAUNEE- NER	1995 (100)	Now the “Lakeshore GMU”
SEWRPC (Root R.) SER	1995	DNR will develop report in 2000
SEWRPC (Fox River (IL)) SER	1995	DNR will develop report in 2000
SEWRPC (Milwaukee) SER	1995	DNR will develop report in 2000
BAD AXE LACROSSE – WCR	1994 (79)	Public Review Completed in 1999
ST. CROIX - NOR & WCR	1994 (269)	
UPPER GREEN BAY- NER	1993 (238)	
BLACK –WCR	1992 (87)	Public Review Completed in 1999
UPPER WI SOUTH - WCR	1992 (213)	Now part of the “Central Wisconsin GMU”
LOWER WI - SC, WC	1992 (201)	
LOWER FOX - NER	1991 (24)	Public Review Completed in 1999
UPPER WI CENTRAL- WCR	1991 (221)	Now part of the “Central Wisconsin GMU”
GRANT-PLATTE - SER	1991 (105)	Internal Review Completed in 1999
UPPER FOX - NER	1990 (272)	Internal Review Completed in 1997

Water Quality Plan Summaries

Following are summaries of plan updates that have been completed over the last four years from 1996-99.

Lower Rock River Basin

The Lower Rock River Basin plan was published in October 1998. It describes the water quality in this highly developed tributary to the Mississippi River. The 1,857 square mile basin is a mix of agriculture and urban/suburban areas. Paradoxically, the area boasts some of the state’s most productive and rapidly converted farmland. The basin’s most populous areas include Madison, Monona, Sun Prairie, Janesville, Beloit, Fort Atkinson, Stoughton, Edgerton, Whitewater, Hartland, Delevan and Delafield.

The basin’s fifteen watersheds include larger, slow moving, turbid rivers, such as the Yahara River, as well as cold water trout streams, such as the Rutland Branch of Badfish Creek and Spring Creek in the Badfish Creek watershed. Water quality impacts from agricultural and urban activities are discussed in the report. The primary water quality issues include: altered stream and groundwater hydrology; continued loss of aquatic and riparian habitat; sedimentation of streams, natural lakes and millponds; pesticide and nitrate contamination of groundwater; and increased quantity and reduced quality of stormwater runoff. Water quantity issues are also of concern, particularly in the Lake Mendota and Lake Monona watersheds. The Madison metropolitan area continues to grow, putting increased pressure on local groundwater supplies, wetlands and streams.

Sheboygan River Basin

The Sheboygan River plan, published in April 1999, describes the water quality in this 614 square mile basin, which is tributary to Lake Michigan. The basin is largely agricultural, with natural areas accounting for the second largest land use. There is increased pressure for development throughout the area. Water quality issues, related to agricultural and urban activities, are discussed in the report. Polluted runoff, contaminated sediment, stream channelization, habitat modifications, and impoundments all affect the surface and groundwater quality in the basin.

Baseline water quality monitoring from 1994-99 indicates that the major streams – the Sheboygan River, Mullet River, Onion River and Pigeon River – have relatively good water quality, particularly in the headwater areas. PCB contamination in the lower 14 miles of the Sheboygan River continues to be a major concern and focus of monitoring, modeling and remediation efforts.

A general overview of the water quality in each of basin's six watersheds is presented in the basin report summary. The Sauk Creek and Suck Creek Watersheds are characterized as fair to poor, the Black River as poor, the Sheboygan River as good in the headwaters and fair to poor in the lower reaches (the PCB problems extend from the mouth 14 miles upstream), the Onion River as good to excellent in the headwaters and fair to poor in the lower sections, the Mullet River as fair to good, and the Pigeon River as good in the headwaters and fair to poor in the lower reaches.

Buffalo-Trempealeau Basin

The Buffalo-Trempealeau plan, published in December 1996, describes the water quality in this 1452 square mile basin, which is tributary to the Mississippi River. This largely cropped (56%) and forested (40%) management area contains three subbasins of the driftless area—the Buffalo River, Waumandee Creek and the Trempealeau River. The driftless area is unglaciated and is characterized by long narrow valleys with steep ridges. Only a small portion of land in Buffalo County was glaciated. Agriculture dominates the basin, except for those areas too steep to farm, which are largely forested. Small, high-quality cold waters are feeder streams to larger rivers that flow to the Mississippi River.

Alteration of stream stability and resulting changes to channel morphology, soil erosion and water temperatures has been studied in this area. Promotion of runoff from conversion of forested lands to agriculture and residential use has significantly affected the water quality. Steambank pasturing, stream channeling, dams and barnyard runoff also contribute heavily to water quality concerns. Construction site erosion from increasing development throughout the basin has become an issue, because development has occurred primarily on steep slopes. Four priority watershed projects are either ongoing or completed in this basin and two additional watersheds (the Lower Buffalo River and the Upper Buffalo River) are ranked high for the program.

The Millpond Element of the basin plan describes the unique characteristics of small impoundments, including their vulnerability to sedimentation and poor water quality, degraded aquatic communities, and options for restoration management or dam removal.

Manitowoc Basin

The Manitowoc plan, published in May 1997, describes the water quality in this 656 square mile basin located in the Northeast Region. This basin is now part of the Lakeshore Geographic Management Unit. Water quality in this predominately agricultural area is degraded by polluted runoff, most notably in the Branch River Watershed. These waters have had the highest soil erosion rates in the basin due to cropping practices. Filling, erosion problems, and nutrient loadings and pesticide runoff threaten the basin's 62,191 acres of wetlands. In addition, contamination from Superfund sites in the basin is a concern.

This plan update focuses on these issues, as well as important aspects of the basin's relationship to the water quality of Lake Michigan. There are many direct and indirect tributaries to Lake Michigan in the basin including Sevenmile Creek and Silver Creek. Tributary streams can and do support seasonal migration of brook trout, rainbow trout, coho salmon, smelt and other fish species found in Lake Michigan. Fish spawning is threatened by siltation, which destroys instream habitat. Fish kills attributed to erosion and runoff have occurred in smaller tributary streams. As in other areas of the state, increasing development and resulting stormwater impacts are also a concern. Protection and management of the basin's lakes and wetlands, such as the Collins Marsh and Brillion Marsh Wildlife Areas, are also high priority issues.

Unique to this area is the underlying karst geology, which is highly susceptible to groundwater pollution. Because communities in the basin rely on groundwater for drinking water, successful implementation of practices to curb polluted runoff is very important. In addition, PCB contaminated sediments have been found in Hayton Millpond and more than six miles upstream between New Holstein and the millpond. A remediation plan is being developed by the WDNR and Tecumseh Products Company to address the contaminated sediment issue (refer to the Contaminated Sediment Management Section for a discussion of Hayton Millpond).

The Lake Superior basin has a multitude of high quality water resources.

Superior Basin

The Superior Basin Plan, published in March 1999, describes the water quality in this 656 square mile basin in the northwest part of Wisconsin. The plan provides an inventory on the state of the basin, which is comprised of 16 watersheds located in Douglas, Bayfield, Ashland, Iron and Vilas Counties. Recommendations in the report support ongoing efforts on the Lake Superior Binational Program.

Tributary to one of the nation's greatest national treasures, Lake Superior, the area supports a multitude of high quality water resources and biotic communities. Because of the outstanding quality of these resources, the basin attracts researchers dedicated to better understanding the unique communities found there. Consequently, this plan summarizes much of the information developed through research projects.

Approximately 71,696 people live in the Wisconsin portion of the Lake Superior Basin. Forestry and recreation are the dominated uses with much of the area in wooded tracts dotted with lakes, streams and wetlands. Agricultural activities in the basin are limited by infertile, highly erodible red clay soils. Thus, even though agriculture is not a major land use, the erodible soils pose a runoff problem with resulting concerns for water quality and instream habitat.

Since 1991, the following activities have been implemented in the basin:

- research on erosion of the red clay soils in the region,
- inventory of critical wetland habitat,
- habitat work on Whittlesey Creek, a priority watershed project,
- stormwater planning and management in the city of Superior, and
- monitoring and remediation work on Newton Creek.

Crawford Creek has been better characterized and some point sources and dam operations have been discontinued. Sediment sampling has been conducted around the Apostle Islands and the Lower Bad River to establish background levels of certain pollutants. Monitoring activities were conducted to characterize the impacts of mine seepage on the Montreal River.

Local Water Quality Aid Program

The Local Water Quality Planning Aid (LWQPA) Grant Program is designed to support local and regional water quality planning activities that assist WDNR watershed management planning activities. Grant priorities are determined based on statutory requirements, bureau priorities and emerging issues. WDNR receives authority for this grant program from 604(b) of the Federal Clean Water Act, s. 281.51, Wisconsin Statutes and from Chapter NR 121 of the Wisconsin Administrative Code.

Grant Priorities and Eligibility

Financial support is provided to local and regional planning agencies to assist the WDNR in the development of watershed and areawide water quality management planning activities.

The first priority is the funding of water quality implementation in designated management areas of the state, as defined in NR 121. These areas include the Southeast Wisconsin Regional Planning Commission (seven counties in southeastern Wisconsin), Dane County, and the Fox Valley Region that encompasses Brown County and portions of the East Central Regional Planning area.

A second priority are those areas in the state that are required to develop sewer service area plans, or long-term plans that identify where public sewers will be placed in the future (refer to the Sewer Service Area Planning section). Municipalities with populations greater than 10,000 are required under law to develop such a plan. These are called “undesignated” or “nondesignated” management areas (designated versus undesignated planning areas). This grant program generally funds the first of these plans for the community. The community is then responsible for the implementation of the plan, including updates.

A third priority is plans and studies that support watershed management. Examples include municipal stormwater analyses for municipalities with populations greater than 10,000, regional wastewater facility planning studies, identification and protection of environmentally sensitive areas (environmental corridors), or special watershed studies in support of pollution trading.

A sampling of the projects recently funded through this program include:

- City of Marshfield Sewer Service Area Plan development awarded to the North Central Regional Planning Commission (FY 2000),
- City of Baraboo Sewer Service Area Plan Development and Stormwater Analysis awarded to the City of Baraboo (FY 2000),
- City of River Falls Sewer Service Area Plan Development awarded to the City of River Falls (FY 2000),
- Jamestown Sanitary District Wastewater Alternatives Study awarded to the Jamestown Sanitary District/Wisconsin Community Action Program Association (FY 2000),
- Village of Luxemburg Sewer Service Area plan development awarded by Bay Lake Regional Planning (FY 1999),
- City of Milton Regionalization Study (FY 1999),
- Environmental Corridor Study for Manitowoc and Sheboygan Counties awarded to Bay Lake Regional Planning Commission (FY 1999),
- LaCrosse Sewer Service Area Plan Update (FY 1999),
- City of Superior Sewer Service Area Plan Update (FY 1998), and
- Ongoing water quality management planning activities by Brown County Planning Department, Southeast Wisconsin Regional Planning Commission, East Central Regional Planning Agency and Dane County Regional Planning Agency.

Sewer Service Area Planning

Sewer Service Area Planning tries to anticipate a community's future needs for wastewater treatment. This planning helps protect communities from adverse water quality impacts through development of cost-effective and environmentally sound 20-year growth plans for sewerage systems. A sewer service area plan identifies existing sewered areas, as well as adjacent land most suitable for new development. This planning also identifies areas where sewers should not go because they are environmentally sensitive and would cause adverse impacts on water quality.

Sewer service area planning plays an important role in keeping Wisconsin's water safe for drinking, recreation and fish and aquatic life. The plans are designed to provide structure to a community's wastewater collection system. The plans also accommodate current and future growth while at the same time consolidating wetland, shoreland and floodplain protection programs within a community-based plan for sewered development.

Authority for Sewer Service Area Planning

In the Federal Water Pollution Control Act Amendments of 1972 (PL92-500), federal law created a process to establish locally developed areawide water quality management plans or basin plans. Areawide water quality management planning was codified at the state-level through the development of NR 121, Wisconsin Administrative Code. NR 121 specifies that Areawide Water Quality Management Plans include components that deal specifically with sewer service areas and projected needs for 20 years into the future. Sewer Service Area plans and related water quality plans are sometimes referred to as Section 208 plans due to the original stipulation in the Clean Water Act for Areawide Water Quality Management Plans.

Under Wisconsin statutory authority in Chapters 144.025(1) and (2), and 147.25, Wisconsin Statutes, and Chapter 121, Wisconsin Administrative Codes, sewer service area planning is performed by governor-appointed "designated planning agencies" for the most heavily urbanized areas of the state and by the WDNR in "non-designated areas." NR 121 also established procedures whereby local entities can be identified as designated planning agencies by a certification from the Governor to U.S. EPA.

In "undesignated areas," sewer service plans must identify sewer service for selected urban locations within standard metropolitan statistical areas and for areas with populations exceeding 10,000 (as per NR 121.05(1)(g)(4)). Urban areas with wastewater treatment plants that treat 1.0 million gallons per day or more within standard metropolitan regions are included in the sewer service area planning process. There are 28 municipalities in the state that fall under this "undesignated area" definition. Most of these 28 areas have an approved sewer area plan. Only a handful (6) require the development of an initial plan to come into compliance with state law. Table 9 provides a listing of the undesignated areas showing which ones are completed or in progress and which ones have not been initiated.

While the federal and state law established the concept, the substantive and procedural details of sewer service area planning have evolved at the state and local levels to meet the needs of resources and stakeholders. Sewer service area plans are submitted to WDNR for approval or denial. Generally, WDNR funds the local technical work needed to prepare the plan.

Sewer service area planning authority for water quality protection is limited to areas with wastewater treatment. However, through the planning process, state, local and regional authorities voice their concern about placement of structures or other development in environmentally sensitive areas. This helps sewer service area planning guide local growth within the myriad planning processes and mult-level authorities involved in development. This focused integration is designed to avoid negative impacts to water resources both on a local and regional basis.

Table 9. Undesignated Sewer Service Areas and SSA Plan Status

City, County	Population (1999)*	Plan Required	Plan In Place?
STURGEON BAY, Door	9,483	No	Yes
PLATTEVILLE, Grant	10,030	Yes	No
MERRILL, Lincoln	10,389	Yes	Yes
BARABOO, Sauk	10,487	Yes	Yes
MONROE, Green	10,638	Yes	No
PLOVER, Portage	10,664	Yes	Yes
FORT ATKINSON, Jefferson	11,342	Yes	No
WESTON, Marathon	11,660	Yes	Yes
RIVER FALLS, Pierce, St. Croix 9,510+2,186=	11,696	Yes	Yes
MARINETTE, Marinette	12,061	Yes	Yes
CHIPPEWA FALLS, Chippewa	13,213	Yes	Yes
TWO RIVERS, Manitowoc	13,445	Yes	Yes
WHITEWATER, Jefferson, Walworth 2,582+10,920=	13,502	Yes	No
MENOMONIE, Dunn	14,591	Yes	Yes
ONALASKA, LaCrosse	15,080	Yes	Yes
BEAVER DAM , Dodge	15,130	Yes	Yes
WISCONSIN RAPIDS, Wood	18,989	Yes	Yes
MARSHFIELD, Wood, Marathon 19,465+504=	19,969	Yes	Yes
WATERTOWN Dodge, Jefferson 8,002+13,149=	21,151	Yes	No
STEVENS POINT, Portage	24,428	Yes	Yes
SUPERIOR, Douglas	27,294	Yes	Yes
MANITOWOC, Manitowoc	34,469	Yes	Yes
BELOIT, Rock	36,226	Yes	Yes
WAUSAU, Marathon	38,881	Yes	Yes
FOND DU LAC, Fond du Lac	41,363	Yes	Yes
SHEBOYGAN, Sheboygan	51,138	Yes	Yes
LA CROSSE, LaCrosse	52,523	Yes	Yes
JANESVILLE, Rock	59,626	Yes	Yes
EAU CLAIRE Eau Claire, Chippewa 59,395 +1,755 =	61,150	Yes	Yes

* Population Projection from the Wisconsin Department of Administration website

Data Systems

WDNR has committed to using Geographic Information Systems (GIS) as a tool for water quality management, employing the systems ability to integrate data and assist in analysis. GIS links information from diverse sources with a geographic layer of information, allowing managers to pinpoint problems on a map and use the system to identify potential problem areas. WDNR has developed a statewide 1:24,000 scale hydrographic data layer that provides a more detailed analysis than available in the past. The current GIS data layer, supported by U.S. EPA, is at the scale of 1:100,000, which is frequently not detailed enough for small steams or wetland sites. Part of the development of the new hydrographic layer includes integrating the state's waterbody databases. The Master Waterbody File and Surface Water Inventory have been incorporated into the Register of Waterbodies File, thus ensuring that each waterbody has a unique identification number. WDNR would like to link the U.S. EPA's new Access Database, with all the summary water quality data for each of Wisconsin's waterbodies, to the 1:24,000 hydrolayer. This information would be used both internally by the WDNR, externally by other agencies and would be made available to the public via the WDNR's website.

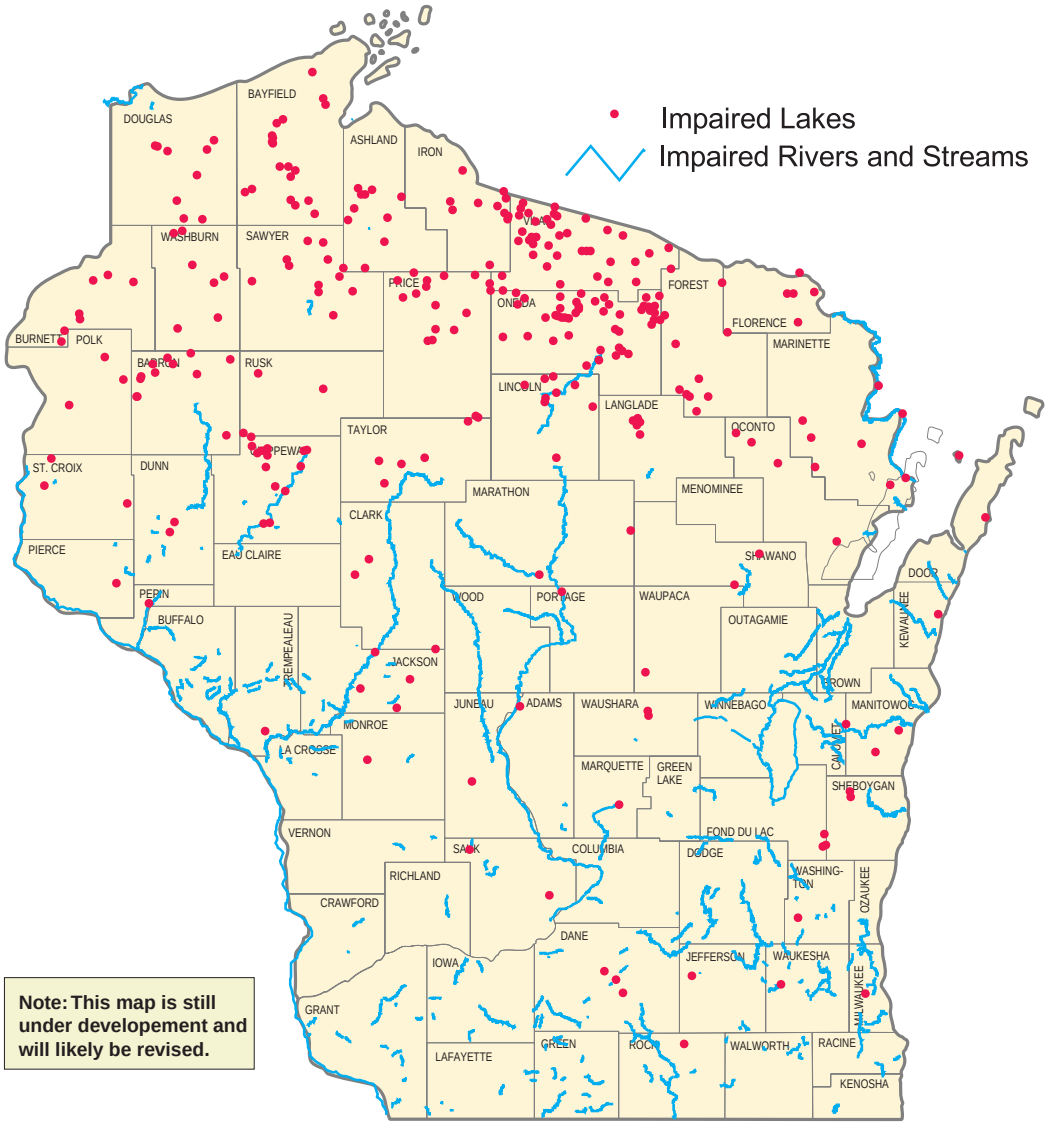
Impaired Waters Program

Identification and management of the state's impaired waters stems from Section 303(d) of the Clean Water Act. U.S. EPA requires that the listing of waters under Section 303(d) must occur every two years. The list identifies waters, which are not meeting water quality standards, including both water quality for specific substances or designated waterbody uses. The list is used as the basis for development of Total Maximum Daily Loads (TMDLs) under the provisions of Section 303(d) of the Act. WDNR has submitted two lists in the past, which have been approved by U.S. EPA, once in December 1996 and again in March 1997. The 1996 list was supplemented by additional waterbodies identified in revisions made in 1998. Wisconsin's 1998 list is in substantial conformance with U.S. EPA guidance issued in August 1997. Figure 7 shows the location of the impaired waters in Wisconsin.

The 1998 303(d) listing represents a comprehensive list of impaired waters. Such a list is intended to highlight waters in the state, which require water quality improvement and protection. The comprehensive list enables the WDNR, in corporation with the public participation through Geographic Management Unit partnership teams, to prioritize where program emphases should be placed. The list is based upon an objective evaluation of the best water quality information available, not upon any nonscientific factors.

The inclusion of a water on the 303(d) list is based on measured exceedances of water quality criteria or a determination that designated uses (those uses which are codified in water quality standards regulations) are not being met. However, given the high quality of the state's water resources, the list represents only a small fraction of the streams and lakes in the state. The inclusion of additional waters on the 1998 list, beyond those listed in 1996, does not mean the quality of Wisconsin's waters is declining. In fact, there has been a tremendous improvement in water quality of the state's lakes and streams over the past 25 years. If a similar list had been developed in 1970, it would have contained considerably more streams and lakes than either the 1996 or 1998 lists. Wisconsin has organized waters on its 303(d) list by the following categories: point source dominated, nonpoint source dominated, point and nonpoint source combined, contaminated sediment waters, atmospheric deposition, habitat/physical impairment, and "other." These categories aid in development of management approaches to remediate identified problems.

Figure 7. Draft map of Wisconsin's impaired waters.



Watershed-based Trading

Water quality trading is a market-based watershed approach to improving water quality. Watershed-based trading allows two parties, under the control of an agreement, to be involved in pollutant trading. The trading allows one entity to remove or limit additional pollutant discharges while allowing the other entity to discharge more. As a tool in watershed management, all sources may contribute to reducing pollutant loading without any one entity bearing an excessive financial burden. The shift in pollutant loading responsibility can result in a more equitable, efficient, and cost-effective way to address water quality problems.

In addition to the economic benefits, pollutant trading has also been shown to provide environmental benefits greater than those achieved by existing regulations. A number of successful projects and programs have demonstrated how trading can be applied to achieve the goals of the Clean Water Act and implement state water pollution control efforts. Clear legal authority, environmental drivers and well-designed programs are necessary for trading to occur.

Efforts to evaluate pollutant trading in Wisconsin began with Act 27 of the Laws of 1997 (S. 283.84, Wis. Statutes). Act 27 authorized the WDNR to administer at least one pilot project to evaluate the trading of water pollution credits. Under this law, a permittee would be allowed to discharge pollutants above what they would otherwise be authorized in their permit as part of the pilot project provided one of the following conditions is meet:

- Another permittee would be willing to reduce their pollutant load to levels below their existing permit limits (referred to as point to point trading).
- Another entity, not requiring a discharge permit, would be willing to reduce their pollutant loading (referred to as point to nonpoint trading).
- The WDNR or another unit of government would be willing to accept payment that in turn could be used to reduce pollutants (referred to as brokering).

The criteria for selection of the projects included:

- The area is the watershed or a portion of the watershed of an impaired waterbody.
- The area includes both agricultural and municipal sources of water pollution.
- Potential participants in the area must exhibit an interest in participating in the pilot project.

Several other conditions were established as part of the legislation including: a local advisory was to be set up, persons engaged in mining activities could not enter into such an agreement, and permits must be written to reflect the agreements set up. The budget provided for $100,000 in the 1998-99 biennium to be spent for trading of water pollution credit.

The primary goal of pollutant trading is to ensure that water quality goals are met throughout a watershed, by allowing reductions in pollutants from all sources to be cost-effectively achieved. Under the umbrella of this larger goal, the WDNR has several other goals that will also help meet the statutory requirements:

- To evaluate the potential for pollutant trading,
- To develop and evaluate a framework for watershed-based trading,
- To allow trades to move forward if trading appears to be viable and willing partners come forward in the pilots, and
- To have a process in place at the end of two years to allow future trades.

Some of the challenges facing the WDNR in the development of a trading framework are technical, economic, regulatory and administrative.

The WDNR selected the Red Cedar River, Fox-Wolf and Rock River Basins as the three pilot areas to explore the feasibility of watershed-based pollutant trading. Phosphorus has been identified as the primary pollutant of concern for all three basins. The main objective of these pilot projects is to explore cost-effective and geographically targeted solutions for phosphorus reduction in these three basins. Each pilot study should help answer questions related to the legal, economic and technical aspects of watershed-based trading.

Red Cedar River Watershed

The Red Cedar River Watershed is in west central Wisconsin in the Lower Chippewa River Basin. Northern parts of the basin are predominantly forested, and agriculture is the dominant land use in the rest of the basin. There has been, and continues to be, extensive monitoring within the Red Cedar Watershed to evaluate water quality, to identify the causes of impaired conditions and to gather public perception on goals to be set. However, additional monitoring is needed to collect information on all the impoundments and lakes in the watershed. Without this information on how to improve water quality conditions throughout the watershed, cooperation among potential partners is unlikely.

The City of Cumberland has made the most progress toward implementation of a trade to offset their phosphorus discharge. They are seeking to implement a phosphorus trade on any lands that drain to the Hay River above the Prairie Farm Flowage. In cooperation with the Barron County Land Conservation District, the city is hopeful that appropriate nonpoint

reductions in phosphorus loadings can be achieved in trade for not implementing phosphorus removal at their wastewater treatment plant. Other facilities are in the process of evaluating trading to meet phosphorus limits, including the Cities of Colfax and Turtle Lake and the Turkey Store wastewater treatment facility.

Rock River Basin

The Rock River Basin is located in south central Wisconsin. Nutrient trading has been actively discussed in this area since about 1996, and current efforts are centered on phosphorus management. A workplan has been developed containing several specific elements. Modeling will determine which parts of the basin are the largest sources of phosphorus. Monitoring will allow calibration of the model and an evaluation of changes in water quality. In addition, an element of the work plan will permit development of a standardized framework so that pollutant trading can occur with a minimum of overhead costs. Included in that effort will be a comprehensive evaluation of legal, organizational and economic issues. The Rock River pilot project has researched the effectiveness and cost of best management practices for nonpoint sources and evaluated the biological impact of phosphorus in the system.

Fox-Wolf Drainage Basin

The Fox-Wolf Drainage Basin covers a large area in the northeast part of the state. The watershed-based trading team, headed by the Fox-Wolf Basin 2000 organization, has completed a number of actions over the last year, implemented others and made plans for additional activities to be completed in the future. To support the watershed-based trading activities, Fox-Wolf Basin 2000 has solicited grants from a number of sources to:

- Research the economic and legal basis for watershed-based trading;
- Communicate and inform the public about trading;
- Participate on advisory groups addressing trading;
- Participate in the nonpoint source program redesign; and
- Conduct modeling for three sub-basins in the Fox-Wolf Basin.

A series of meetings were held in 1999 with the stakeholders in each of the three sub-basins to inform and educate the participants bout the concept of watershed-based trading and to determine if interest exists in this area. A final report to the agencies that are providing grant funds is due in April 2000.

Future Efforts on the Pilot Projects

While the WDNR is waiting for the pilot projects to provide insight into various questions regarding implementation of watershed-based trading, WDNR staff have consulted with the Watershed Advisory Committee and contracted for other research studies to provide additional technical background. The research investigations have evaluated how best management practices may reduce phosphorus discharges from nonpoint sources. It has also shown that levels of phosphorus impact the riverine surface waters differently depending on the size and characteristics of the stream. The WDNR has continued to make progress in evaluating the potential for watershed-based trading. Over the last year, the three pilot projects have taken different approaches to determining the appropriateness of watershed-based trading in their area. The WDNR and the stakeholder groups have identified and discussed a large number of issues. This year has seen the completion of additional monitoring and modeling work, the resolution of a number of administrative and institutional issues and potentially the first trade of pollutant credits. The expectation for next year includes the completion of trades in the Red Cedar River Basin, finalizing a framework for trading in the Rock River Basin and the identification of the level of interest and the possibility for trading in the Fox-Wolf Basin.

Unified Watershed Assessment

In October 1998, as called for in the federal Clean Water Action Plan, Wisconsin completed and submitted a Unified Watershed Assessment. As called for in the Clean Water Action Plan, the purpose of the assessment is to "identify watersheds that do not meet clean water and other natural resource goals and where prevention action is needed to sustain water quality and aquatic resources". To be eligible for increased funding tied to the Clean Water Action Plan, states were required to develop these assessments in a two to three month period. The WDNR and the Natural Resources Conservation Service (USDA) took the lead in Wisconsin in developing the assessment. Portions of the Unified Watershed Assessment are on the WDNR website.

Wisconsin developed its Unified Watershed Assessment in cooperation with a number of federal, state and local agencies and the Tribes. The assessment is identified for restoration and protection based on the following factors:

- The extent of impaired waters on the 303(d) list with impairments caused by nonpoint sources or a combination of point sources and nonpoint sources;
- The extent of individual lakes and streams needing some level of water quality improvement or protection to fully meet designated uses, as reported and ranked in areawide water quality management plans and as used in the 305(b) reports;
- Preliminary information from the Safe Drinking Water Act source water assessment activities;
- Extent of outstanding and exceptional resource waters (primary factor for protection); and
- Information from Great Lakes Areas of Concern remedial action plans and Mississippi River studies.

The lead agencies desired to incorporate additional information, such as the health of fisheries, greater information on lake water quality and information on wetland conditions. Such information could not be compiled in the very short time to prepare the initial assessment. Federal agency guidance called for the information to be aggregated to watersheds comparable in size to Wisconsin's 22 Geographic Management Units.

The concept of the Unified Watershed Assessment is fundamental to the integrated State of the Basin Plans being developed for each of the Geographic Management Units. However, the State of the Basin Plans will focus on individual lakes, streams, wetlands and other waterbodies. Future Wisconsin Unified Watershed Assessments will be an aggregation of the 22 State of the Basin Plans.

Rivers and Streams

Volunteers

Water Action volunteers assisit in monitoring Wisconsin's rivers and streams.

For Wisconsin's residents, clean water for drinking, recreation and aesthetic enjoyment is an important issue, as demonstrated by the Wisconsin Water Action Volunteers (WAV). WAV is an outreach education program for children and adults. It is an opportunity for Wisconsin citizens to learn more about the quality of the state's waters and become active participants in stream and river education projects. WDNR staff, working with the County Land Conservation Departments, UW-Extension and nonprofit organizations, has provided educational programs and resources to thousands of people in many communities. This outreach has helped WAV program efforts in storm drain stenciling, river and shoreline cleanups, and pilot monitoring projects.

Painting a message next to storm drain inlets has become the water quality hallmark for almost 100 communities across Wisconsin. This highly visible event has educated communities about storm water pollution and ways to curb its effects. With spray paint in hand, volunteers representing 4-H clubs, school groups, religious groups and civic groups have painted storm drains with the message: "Dump no Waste." Brightly colored fact sheets are distributed that explain the origin of stormwater pollution with suggestions of practical ways for an individual to lessen the load. About 1100 volunteers have participated in the storm drain stenciling program each year from 1996-99.

Another activity that WAV is involved in is cleanup of river and stream shorelines. A couple thousand volunteers have picked up about 40,000 pounds of garbage along the banks of Wisconsin's waterways each year from 1996-99. All across Wisconsin, volunteers are joining together to make their local waterways cleaner, safer and healthier for everyone. Much of the success can be attributed to the cooperative effort of local interest groups that make cleaning a river a community-wide event.

Under the leadership of the WAV program, representatives from WDNR, UW-Extension, and interested organizations have been working towards creating a statewide monitoring program for streams and rivers. While still under development, the goal of this part of the program is to standardize monitoring techniques so classrooms, citizen groups and staff are able to share information using the same technology. Volunteer monitoring efforts at two pilot projects—in Dell Creek and in the Pigeon Rive watershed—will be used to shape a statewide monitoring program.

Activity packets are a very popular way to get the message out about WAV. Since the program began in 1994, about 6,400 activity packets have been distributed to the public containing educational materials and hands-on activities specific to rivers and streams. Another WAV outreach effort includes presentations to school groups and volunteers as well as educational displays.

Rivers Strategy

In 1999, the WDNR formally initiated the development of a rivers strategy –Going with the Flow: A rivers strategy to protect, preserve, and restore Wisconsin's flowing waters. The strategy is aimed at bringing a coordinated approach to the support of local river management in the state. It has two main goals: 1) to protect and restore riverine ecosystem integrity and 2) to balance legitimate river resource uses with environmental needs.

The goal of the river program is to protect and restore riverine ecosystems and balance resource uses with environmental needs.

The strategy recognizes that development around river systems and the use of rivers have significantly modified their physical and biological characteristics. In some cases, dams have been constructed and have converted free-flowing rivers into a series of impoundments thus fragmenting these systems. Land use practices have degraded water quality, increased the amount of pollutant loading and increased the rate of sedimentation and nutrient flow to river systems. All these factors influence the integrity of the ecosystem (a combination of the physical, biological and chemical components) which must be protected and in some cases restored, to preserve a functioning riverine system. In addition, decisions on multiple river uses like recreation, waste assimilation, power generation, water supply, irrigation and transportation must be made collectively with the purpose of sustaining both river continuity and socioeconomic benefits. The strategies and work objectives in the rivers initiative include:

- developing a river planning and protection grant program which would award funding for local river management,
- developing a Rivers Team that will act as WDNR experts on river management policy,
- supporting river issues through the integrated planning (basin planning) process, and
- developing a river classification scheme that will enhance riparian protection.

Rivers and Streams Assessment

Assessment of rivers and streams for the 305(b) report is an integral component of Wisconsin's overall Watershed Management Program. For past 305(b) reports, WDNR regional staff has updated watershed tables in the water quality basin plans and that information was incorporated in the U.S. EPA Waterbody System. The data in that system was then downloaded to U.S. EPA to meet the reporting requirements for the 305(b) reports. U.S. EPA has recently improved the waterbody system and sent Wisconsin a copy of that database in the summer of 1999. The data has been "ported" into Microsoft Access, a standard software package of the State of Wisconsin.

One of the reporting requirements for the 305(b) report is an electronic update of the waterbody data files. Unfortunately, Wisconsin received the database too late to complete QA/QC of the data and enter any new information for this 305(b) report. Therefore, an electronic update of the database will not be included as part of this submittal nor will there be an assessment on the number of waters meeting, partially meeting or not meeting designated uses. Efforts are underway by the WDNR to update the database, which will be completed by April 2001. The WDNR will provide U.S. EPA with an update of the electronic database at that time as previously agreed to by staff from WDNR and U.S. EPA Region V.

The surface water database covers assessment data for streams and lakes statewide. All totaled there are 32 water quality basins in Wisconsin. The data contained in the watershed tables in each of the water quality basins has to be compared to the information contained in the U.S. EPA water database. This involves more than 8300 stream/river segments. Specifically, the scope of work includes verification and update of the information contained in the file as follows:

- Verify that the rivers and streams in the watershed tables are located in the database.
- Verify that the information contained in the watershed tables in the basin plans is entered into the system correctly.
- Verify that the stream segments are segmented correctly as they appear in the basin plans.
- Enter any new data into the database that was collected since the last 305(b) report was submitted in 1996.

Of the 32-water quality basin in the state, the rivers and streams in seven of the basins have been verified and updated so far. The final product will consist of a water database that has been proofed, verified and updated for all the lakes and streams with assessment data in the basin plans. In addition, wetland data will also be incorporated into the database and included in the April 2001 electronic update to U.S. EPA.

Mississippi River

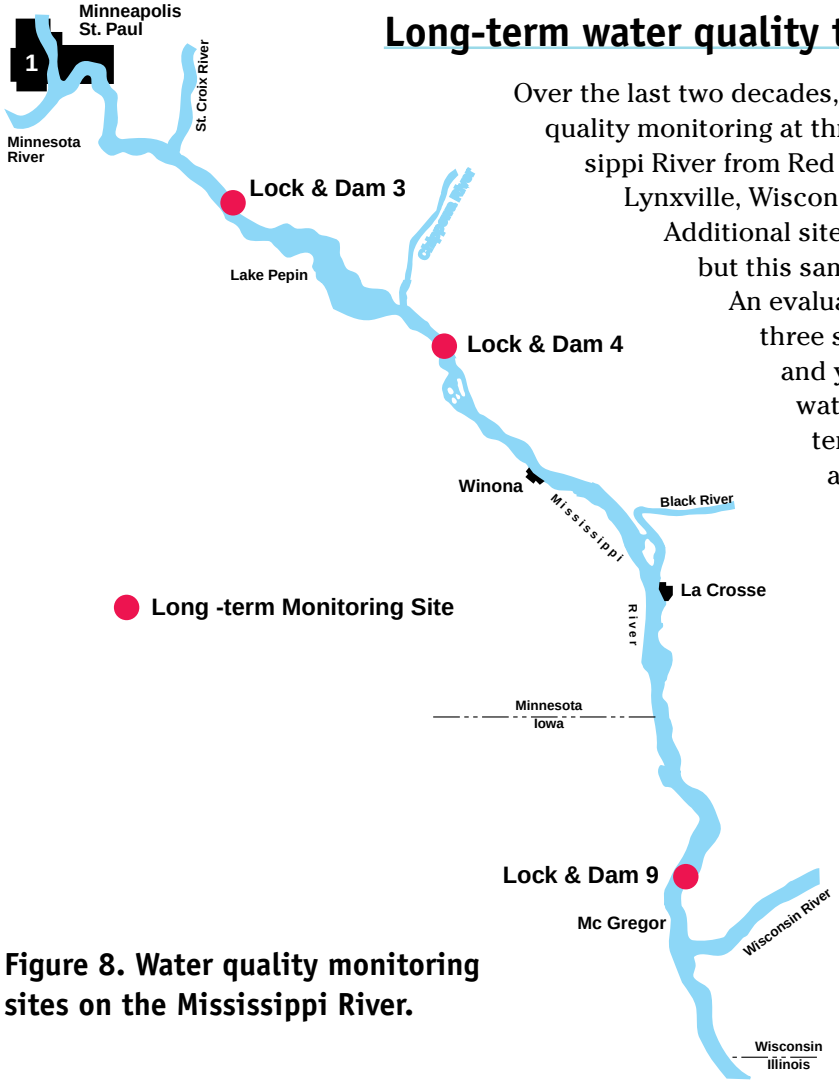


Figure 8. Water quality monitoring sites on the Mississippi River.

Long-term water quality trends

Over the last two decades, the WDNR conducted monthly water quality monitoring at three main channel sites along the Mississippi River from Red Wing, Minnesota (Lock & Dam 3) to Lynxville, Wisconsin (Lock & Dam 9). Refer to Figure 8. Additional sites have been sampled during this period but this sampling was generally limited to ten years. An evaluation of monitoring data from the later three sites was undertaken to assess seasonal and yearly variation in Mississippi River water quality and to identify significant long-term (15-20 year) trends. This analysis was also conducted to help answer a basic question frequently received from the general public, resource agencies, legislators, media and other, "Is the Mississippi River water quality improving or getting worse?" This assessment would also help guide the WDNR future water quality monitoring strategies, including coordinating our water quality assessments and future monitoring efforts with other federal and state agencies.

Water quality in the Mississippi River may exhibit substantial seasonal and annual fluctuations associated with normal and atypical climatic patterns. Seasonal and

annual changes in temperature and precipitation are two of the most important climatic variables that may induce temporal water quality variation in the river. The amount of precipitation is reflected by river flow which is a key factor influencing hydrodynamic (mixing, retention time, re-suspension, transport, etc.) and biological processes in a riverine system.

Tributary inflows and the land use within their watersheds are important factors influencing water quality in the main stem of the river. Runoff from basins with predominantly agricultural land use is a major factor influencing main stem water quality. Point source wastewater discharges influence main stem water quality, but their impacts are more apparent at sites closer to the Twin Cites Metropolitan Area, especially during low flow conditions when the river affords less dilution. Lake Pepin and the navigational pools that may affect physical, chemical and biological processes (i.e. sedimentation, mixing, nutrient cycling, algae and aquatic plant growth) also influence water quality in the river.

In the last 20 years, significant decreasing trends were noted for fecal coliform bacteria, unionized and total ammonia nitrogen in the upper study area (Lock & Dam 3 and 4, Figure 9). Dissolved oxygen concentrations and dissolved oxygen saturation exhibited a small increasing trend over the same period. Municipal point source pollution abatement activities, particularly in the Twin Cites Metropolitan Area, were likely important management activities influencing these positive improvements in water quality conditions.

Nitite+nitrate nitrogen concentrations and loading increased significantly at Lock and Dam 3 and 4 and were probably influenced by increased nitrification associated with advanced municipal wastewater treatment (conversion of ammonia to nitrate nitrogen). However, when all forms of inorganic nitrogen were considered, only a small increasing trend was observed at Lock and Dam 4 (Figure 9).

Conductivity, a measure of dissolved solids, and chloride concentrations increased significantly at all three stations. These were the only parameters exhibiting a significant trend at Lock and Dam 9, the southern most sampling site. Past monitoring in the nation's streams by the U.S. Geological Survey has generally attributed greater chloride concentrations to increased road salt use. However, there are other potential sources including: municipal and industrial wastewater discharges, inflows of contaminated groundwater and runoff of animal wastes, chloride-containing fertilizers, or land-applied wastewaters. These increases in conductivity and chloride do not pose a water quality problem at this time but do provide an indication of likely human-induced impacts on the river's water quality.

Over the last two decades, water quality conditions have shown improvements in the Mississippi River and can largely be attributed to point source pollution abatement activities. Additional nonpoint source pollution control efforts will likely be needed before significant reductions in nutrients and suspended solid concentrations will be realized.

Suspended Sediment Contaminant Concentration Trends

Since 1987, the WDNR has been conducting long-term monitoring of suspended sediments for contaminant concentrations in the Mississippi River at Lock and Dam 3 (Red Wing, MN) and Lock and Dam 4 (Alma, WI). The primary purpose of this monitoring has been to assess long-term trends and to provide an estimate of whole-water particulate-phase concentrations.

Suspended sediment or particulate matter represents a major portion of contaminant transport, especially in turbid waters like the Mississippi River. Organic chemicals such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) or organochlorine pesticides do not dissolve readily in water. These compounds adsorb to fine-grained suspended sediment particles, especially those high in organic matter content. Some contaminant sources include runoff from urban and agricultural land use, deposition from coal and waste incineration, re-suspension of contaminated bed sediments and wastewater discharges.

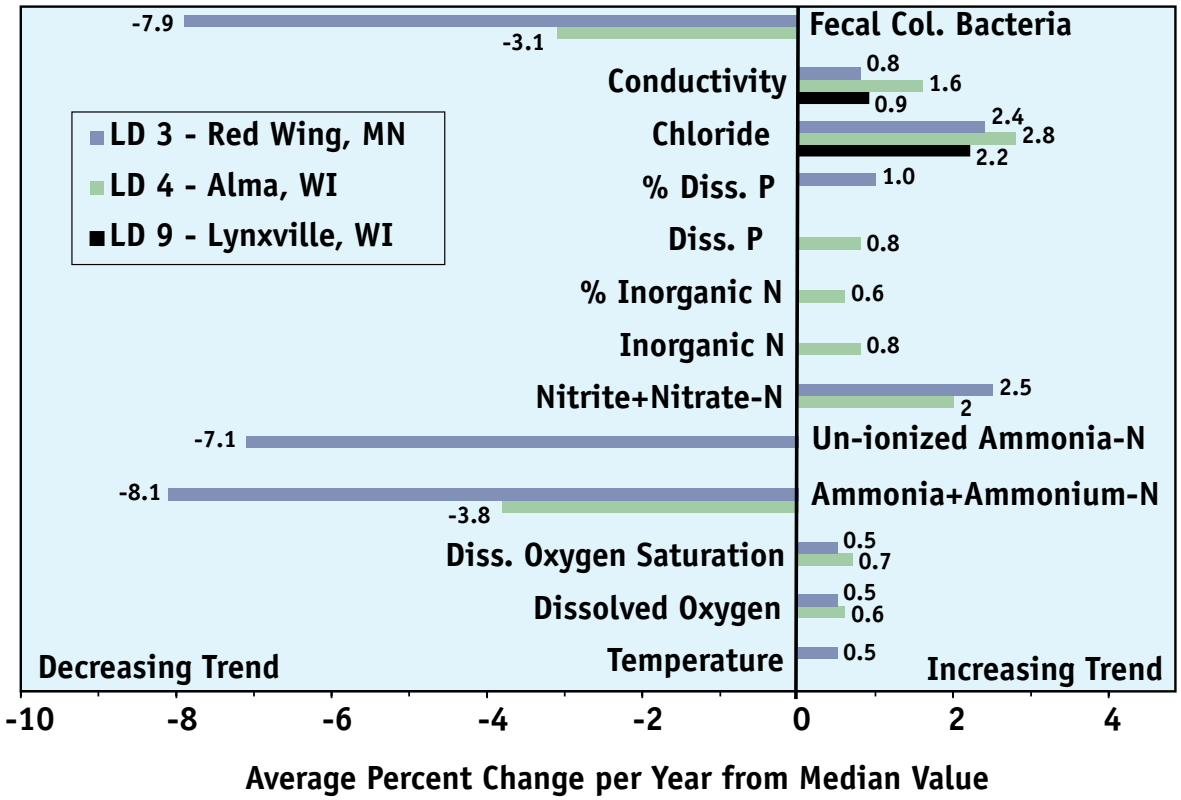


Figure 9. Significant water quality trends observed at Wisconsin's ambient monitoring sites on the Mississippi River at Lock & Dam 3 (near Red Wing, MN), Lock & Dam 4 (Alma, WI) and Lock & Dam 9 (near Lynxville, WI). Trends were established using seasonal Kendall analysis on monthly data collected from 1977 to 1998.

Figure 10 illustrates concentrations of PCBs, lead and mercury in suspended sediment at the two monitoring sites. River flow, the season, sediment particle size, organic matter content, and changes in contaminant inputs influence contaminant concentrations in suspended sediments. PCBs, lead and mercury concentrations in suspended sediments are normally higher in samples collected from Lock and Dam 3 than at Lock and Dam 4. This is due to the closer proximity to the Twin Cites Metropolitan Area, a major source of these contaminants. In addition, Lake Pepin (Figure 8), a natural riverine lake located in navigation Pool 4, acts as a natural sediment trap, which results in decreased transport of these contaminants downstream.

Temporal trends indicate a gradual decrease in PCB concentrations at the two monitoring sites. These data are consistent with fish tissue contaminant monitoring of walleye samples collected from Pool 4, which also shows reduced PCB burdens in the last decade (Figure 11). Suspended sediment contaminant trends for lead and mercury are less obvious, but the concentrations appear to be declining at Lock and Dam 3. Further sampling should help to verify these trends. Past pollution abatement efforts to reduce the use or discharge of contaminants has led to these reductions in concentrations.

Figure 10. A. Total volatile solids-normalized polychlorinated biphenyl (PCB), B. total volatile solids-normalized Lead, and C. total volatile solids-normalized mercury concentrations in sediment trap samples collected from the Mississippi River at Lock and Dams 3 and 4.

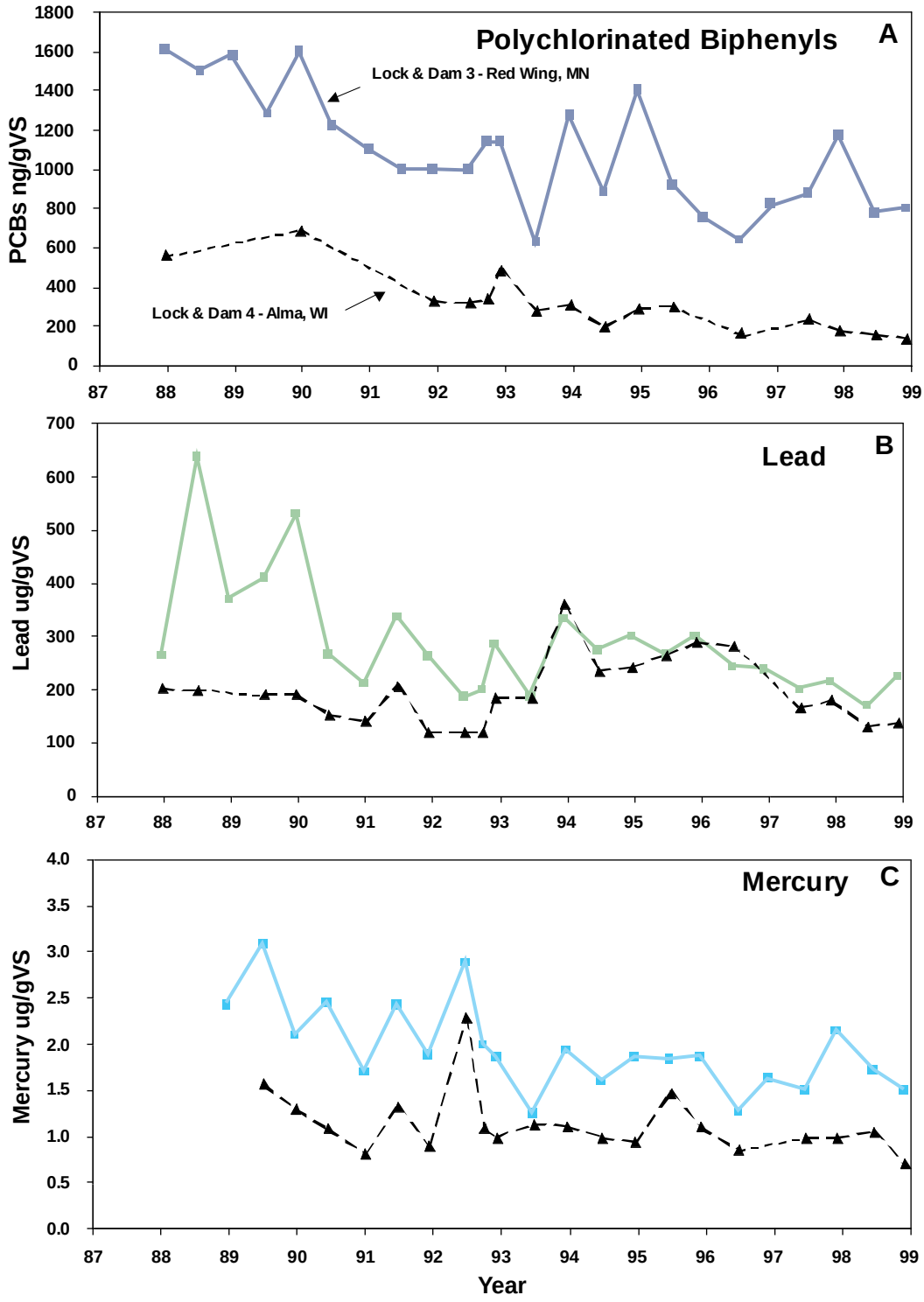
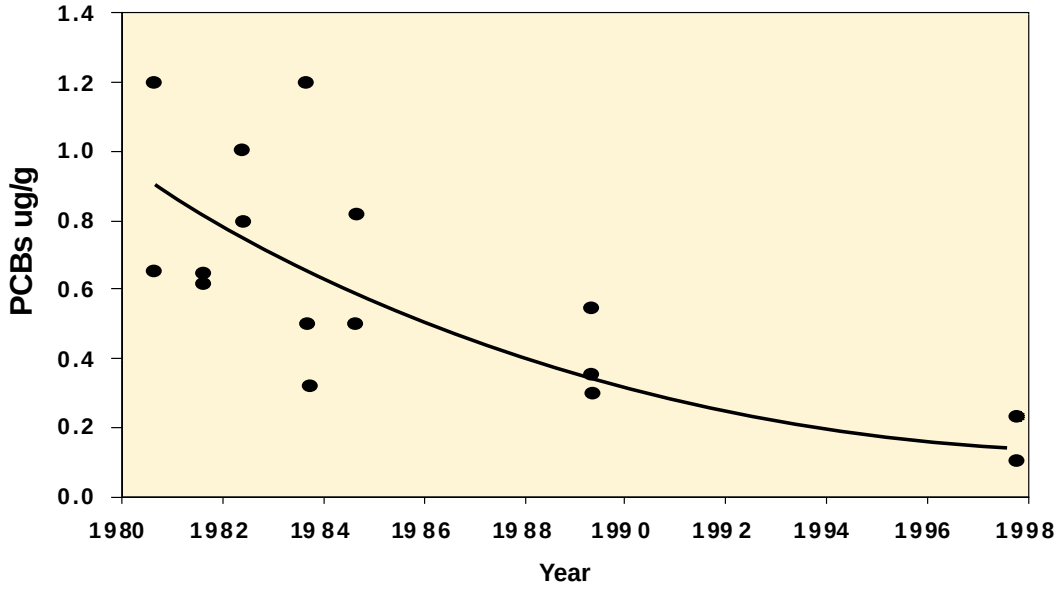


Figure 11. Polychlorinated biphenyl (PCB) concentrations in Mississippi River walleye fillets collected from Pool 4 between 1980 and 1997. Data from Wisconsin DNR's fish contaminant-monitoring program.



Sediment/soil Remediation at Fountain City Bay, Pool 5

Sediments contaminated with PCBs were removed from Pool 5A of the Mississippi River in the spring of 1999. This effort was done as part of a sediment/soil remediation project at the U.S. Corps of Engineer's Service Base at Fountain City. Soils at the service base were found to have elevated concentrations of both PCBs and other organic compounds. Contamination resulted from historic (pre-1980s) disposal of hydraulic fluids and other oils on soil at the Service Base. Previous remediation work was conducted at this site in the 1980s. Subsequent investigations by the Corps revealed additional contaminated soils and sediments at or near the Service Base. The Corps contracted with World Environmental, Inc. in August 1998 to perform the remediation work.

A team from the Mississippi and Lower St. Croix worked with WDNR specialists and the Corps to identify clean-up standards for soils (5 ug/g) and sediment (0.8 ug/g). Mechanical dredging was used to remove 2,485 cubic yards of contaminated sediment from an area of Fountain City Bay adjacent to the northern end of the Service Base. Excavation of 680 cubic yards of PCB contaminated soil was conducted at the service base. Approximately 14% of the higher level PCB contaminated soils (> 50 ug/g) were transported to a licensed landfill facility capable of handling these wastes. All the remaining excavated soils and contaminated sediments were landfilled at a site in Buffalo, Minnesota.

Subsequent sediment sampling efforts by the Corps's consultant and the WDNR revealed the clean-up goal was reached. Although the dredging did mobilize contaminated sediment for a few days, future release to the river should be lower due to the clean-up actions taken at this site.

Long Term Trend Monitoring Program

The WDNR has a field station in Onalaska that is part of a federally funded Environmental Management Program for the Upper Mississippi River System. The Long Term Resource Monitoring Program (LTRMP) component is being implemented by the U.S. Geological

Survey's Upper Mississippi Environmental Science Center at La Crosse and Onalaska. WDNR staff conduct water quality, fishery, vegetation, and invertebrate monitoring primarily in Pool 8 (between La Crosse and Genoa, Wisconsin) on the Mississippi River. The WDNR station at Onalaska is one of six LTRMP field stations located on the Mississippi and Illinois Rivers. The Minnesota DNR operates a similar station on Pool 4 which includes Lake Pepin. Monitoring data is collected using consistent methods and stored in a centralized database to facilitate spatial and temporal data analysis. The data provides an important information base to assess environmental factors influencing the Upper Mississippi River System. Each of the monitoring components is summarized separately.

Water Quality Studies

Water quality monitoring during initial program implementation from 1988 to 1991 was limited to fixed sites, and to in situ physical and chemical measurements. The current LTRMP sampling design (starting June 1993) includes both fixed-site and stratified-random sampling, and combines in situ field measurements with laboratory analyses of chemical constituents. Biweekly fixed-site sampling in the current design includes tributary inputs and river inflows and outflows from each of the LTRMP study areas. Stratified random sampling (SRS) is performed in four quarterly episodes each year, and includes 150 randomly selected sites from five sampling strata within a study pool. Limnological data from SRS are intended to be linked to fish, vegetation, and invertebrate abundance and distribution at the spatial scale (pool or river reach) and at temporal scales ranging from seasons to decades.

From 1988-99, the Onalaska water quality monitoring team conducted about 7,000 site visits to fixed sampling locations and nearly 4,000 SRS locations. Due to the sampling design change in 1993, not all parameters or sites have been monitored across all years. Therefore, only data for selected time periods, sites, and variables are reported. Suspended solids, nitrogen, and phosphorus data were collected but were not available yet for this report for 1996-99 (suspended solids) and 1997-99 (nitrogen and phosphorus).

Data for upper and lower Pool 8 fixed-sites (Figure 12) depict the seasonal variation similar to that reported for the long-term water quality monitoring conducted at Lock and Dams 3, 4 and 9 (see above). Dissolved oxygen (DO) concentrations are typically greater than 5 mg/L, and show the strong seasonal fluctuations related to temperature and oxygen solubility. The seasonal fluctuation of percent oxygen saturation is less distinct, but generally ranges from 80-130% saturation in this stretch of the river. Average suspended solids concentrations are less than 10 mg/L during winter and peak at about 30-60 mg/L during the spring and summer months when sediment loads from snowmelt and rainfall increase.

Some apparent short-term trends and functional aspects of the Pool 8 reach are also evident in the fixed site data. A steady decline in total nitrogen concentrations occurred during the 1991-97 period. Average total nitrogen concentrations during that time period ranged from about 1-6 mg/L. Suspended solids concentrations during the 1993-1996 period also declined slightly, and concentrations were higher at the lower pool site, suggesting tributary loading or sediment re-suspension during wind events.

The summer SRS data (Figure 13) show differences between the main channel and backwaters of Pool 8. With some notable exceptions, the backwaters tend to be slightly warmer, more highly oxygenated, and more turbid (i.e. higher suspended solids concentrations) than the main channel. The apparent decline in main channel suspended solids concentrations indicated by the fixed-site data is also supported by the SRS data. While no definitive trend or pattern was evident in the SRS nitrogen and phosphorus data, differences existed between the main channel and backwater sites that may be explained by factors such as river discharge, weather patterns and nutrient cycling. Further investigation and more detailed analyses are ongoing.

Figure 12. Temperature, dissolved oxygen, percent oxygen saturation, total suspended solids, total nitrogen, and total phosphorus at upper (river mile 701.1) and lower (river mile 679.5) Pool 8, Mississippi River. The two sites approximate inputs and outputs to Pool 8.

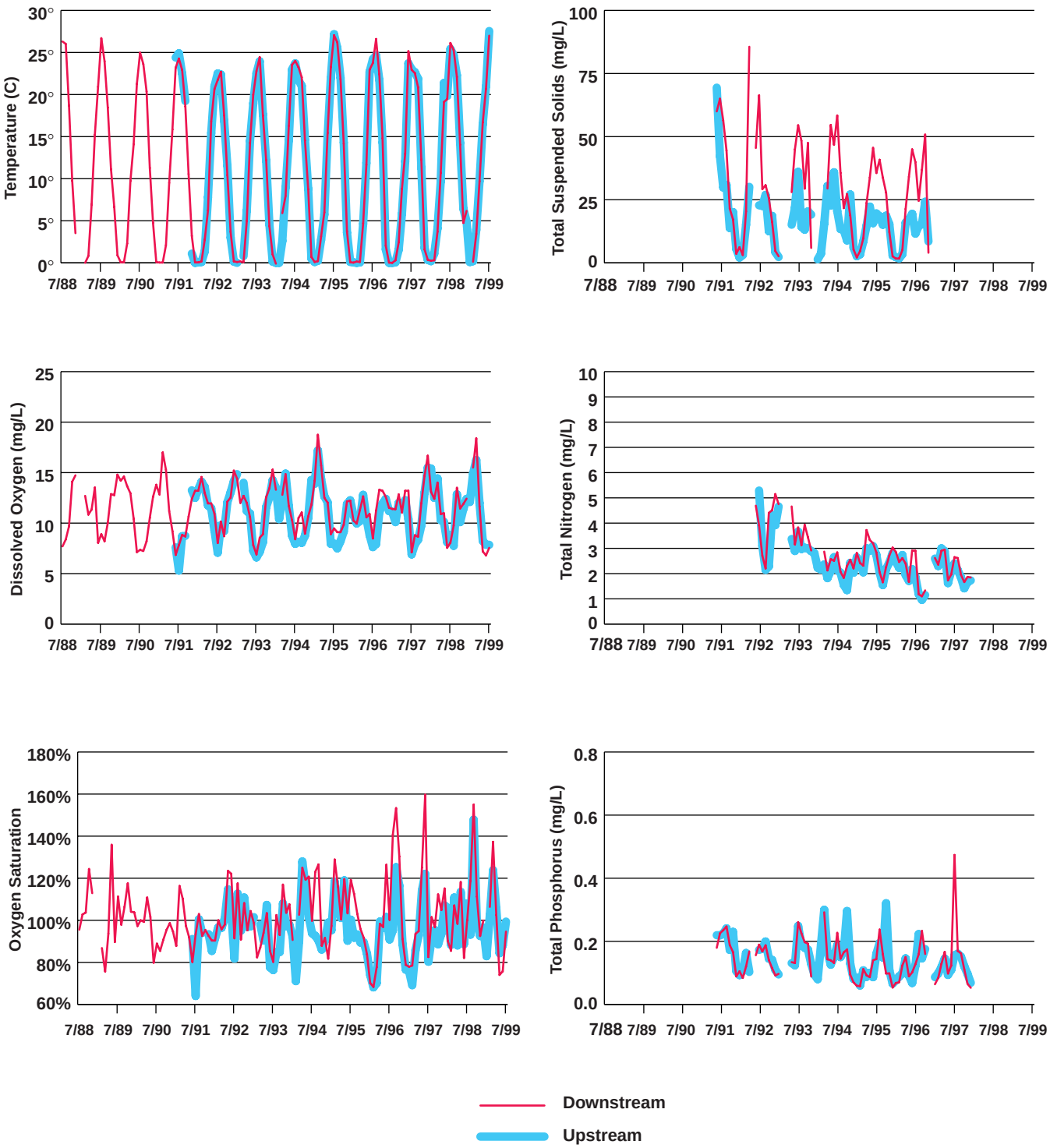
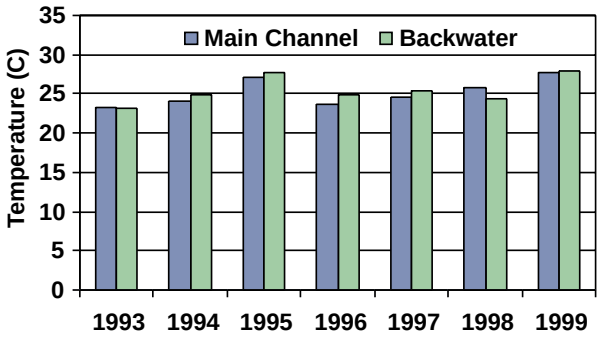
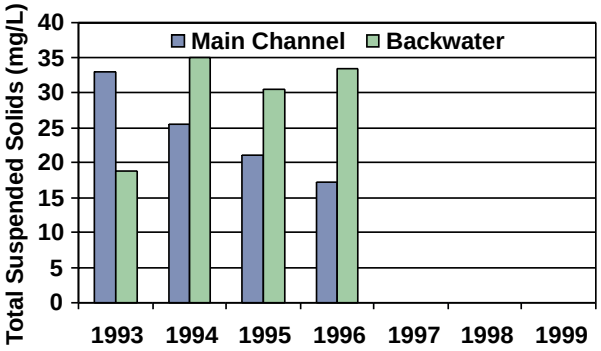
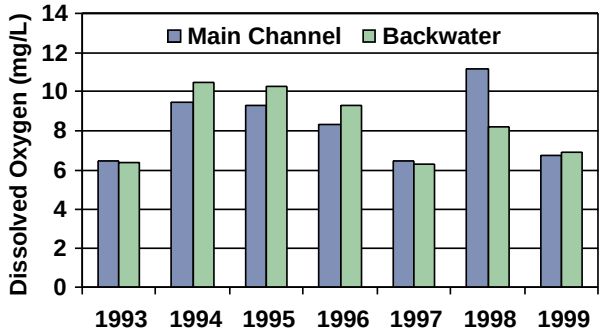
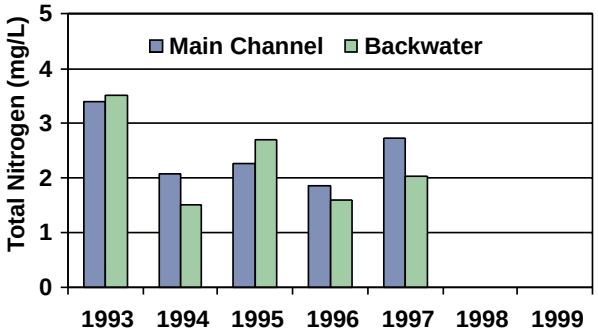


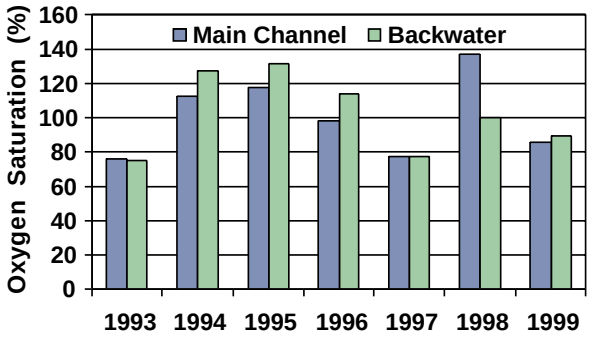
Figure 13. Mean temperature, dissolved oxygen, percent oxygen saturation, total suspended solids, total nitrogen, and total phosphorus in the main channel and backwater strata of Pool 8, Mississippi River, during mid-summer random sampling episodes. Each bar represents the mean of sites randomly selected within each stratum.

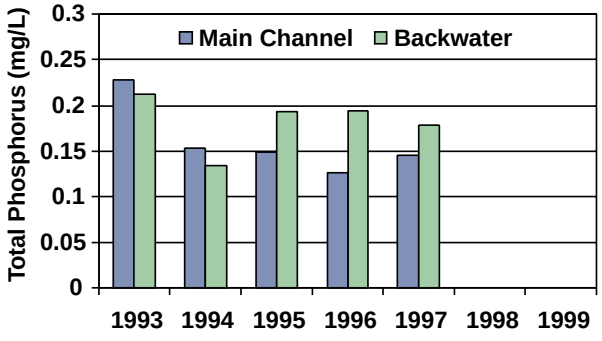












LTRMP Aquatic Vegetation Studies

Since 1991, the Onalaska vegetation-monitoring team has evaluated submersed aquatic vegetation (SAV) in Pool 8 of the Upper Mississippi River. Data were collected along permanent transects to assess vegetation changes in specific backwater areas. Additional backwater areas were established in 1992 and 1993. Since 1993, eight backwaters within Pool 8 have been monitored (Figure 14). These included Target Lake, Lawrence Lake, Goose Island, and Shady Maple, all areas that are connected to the main channel. Blue Lake and Stoddard are isolated from the main channel and Horseshoe and Boomerang Island areas are located in the impounded portion of Pool 8. Sampling was conducted twice each growing season, once in spring (mid-May to mid-June) and again in summer (mid-July to late August). Spring sampling captured data on early season species, mainly curly and sago pondweeds (*Potamogeton crispus* and *Potamogeton pectinatus*). Approximately 2,400 sampling points were visited annually. Sampling points were located every 15 to 30 meters along each transect beginning one meter from shore. Submersed vegetation was retrieved with a rake, identified to species, and recorded.

Prior to LTRMP sampling, a decline in submersed aquatic vegetation was observed in the Upper Mississippi River System. The decline started during the end of the 1987-1989 drought and persisted to 1991. The cause of the decline is unknown. However, several potential factors include nutrient limitation, light limitation, elevated water temperatures in 1988, and biological factors.

Four of the five backwaters (Target Lake, Lawrence Lake, Horseshoe Island, and Shady Maple) that were sampled in the summer of 1991 showed a low frequency of occurrence of submersed aquatic vegetation (Figure 14). Three of the four backwaters (Target Lake, Lawrence Lake, and Horseshoe Island) showed an immediate recovery of submersed aquatic vegetation in 1992. Submersed aquatic vegetation in Shady Maple remained low until 1996. Goose Island exhibited a slight decrease in submersed aquatic vegetation in 1992 and 1993 and then increased steadily. The two backwaters that were isolated from the main channel (Blue Lake and Stoddard) had generally more submersed aquatic vegetation throughout the sampling period. All eight backwaters were at or near their highest percent frequency in 1999. Increased water clarity for the past several years may have contributed to the increase in submersed aquatic vegetation observed in Pool 8. In general, similar responses have been observed in other pools in the river.

Color infrared aerial photos of Pool 8, taken at a scale of 1:15,000, were converted to digital coverages for 1989, 1991, 1994, and 1999. A decline and recovery of submersed aquatic vegetation was also noted through the aerial photo interpretation (Figure 15). Rooted floating-leafed vegetation decreased from 1989 with a slight recovery in 1998, while emergents have not shown a definite trend.

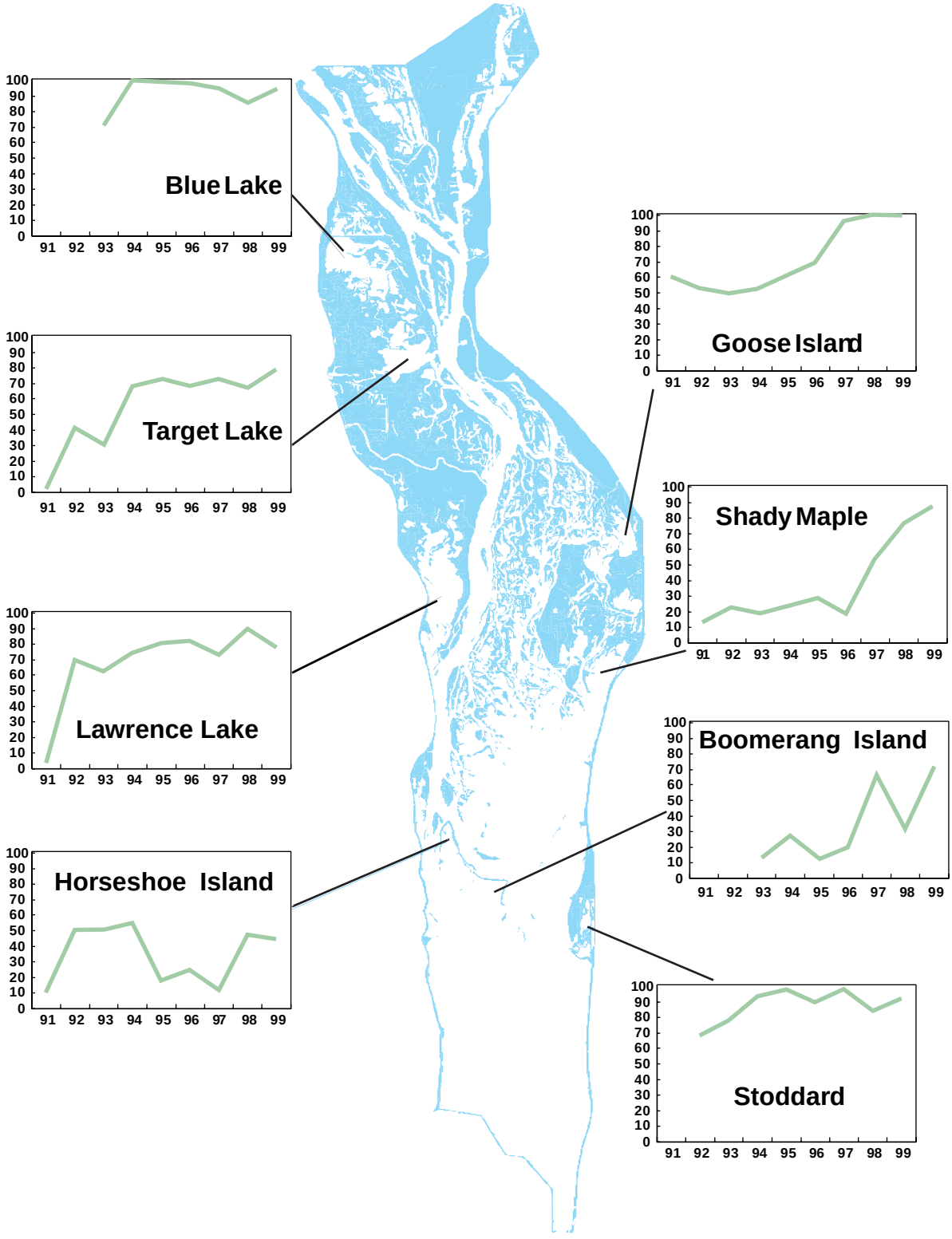


Figure 14. Percent frequency of sampling sites supporting submersed aquatic vegetation in eight backwater areas of Pool 8, Upper Mississippi River. Data represent the summer sampling period for years 1991-1999.

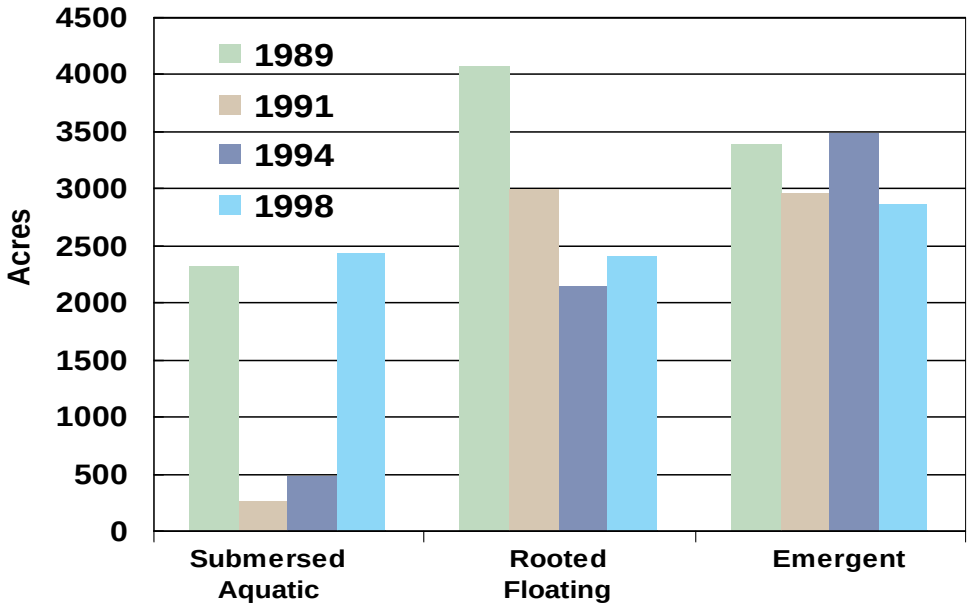


Figure 15. Estimated aquatic vegetation coverage in Pool 8, Upper Mississippi River. Data are based on 1:15000 color infrared aerial photointerpretation.

Habitat Rehabilitation and Enhancement Projects

Section 1103 of the Water Resources Development Act of 1986 authorized the construction of Habitat Rehabilitation and Enhancement Projects (HREP) as one element of the Upper Mississippi River System Environmental Management Program. These projects are selected by biologists and designed by multi-agency teams led by the Corps of Engineers. Input from the public is an important element of planning these habitat projects and is accomplished through public meetings and personal contacts.

HREP's use conventional and experimental techniques to restore and enhance fish and wildlife habitat degraded by human activities that have altered the river ecosystem. A variety of techniques may be used to achieve chemical, physical and biological objectives for projects:

- Dredging sediments to deepen selected backwaters and side channels.
- Constructing dikes and levees to reduce sedimentation in backwaters and control water levels.
- Building islands to reduce wind and wave induced resuspension of sediments.
- Side channel modifications to reduce sedimentation in backwaters.
- Providing flows to isolated backwaters to improve fish habitat.

After construction is completed, all projects are monitored to document chemical and physical responses. Some projects are also monitored to determine if biological objectives are achieved. Wisconsin has sponsored, or co-sponsored, 14 projects which have been constructed in the state since 1986 (Table 10). These projects are located in several different areas of the Mississippi along Wisconsin's western border (Figure 16). Seven projects have also been constructed in Minnesota's and Iowa's waters bordering Wisconsin.

Table 10. Environmental Management Program Habitat Rehabilitation and Enhancement Projects constructed in Wisconsin's waters of the Upper Mississippi River.

Project Name	Pool	Acres Impacted	Features	Monitoring Conducted	Comments
Indian Slough/Big Lake	4	100	Dredging, riffle-pool structure, closing structure, tree revetments	Water quality Bathymetry Fishery	Young-of-the-year smallmouth bass use is high in the riffle-pool structure. Disposal site vegetation well established. Centrarchid response difficult to assess due to sampling effectiveness.
Small Scale Drawdown	5	52	One time water level reduction	Vegetation Sediment	The drawdown was successful at increasing plant diversity and coverage of emergent vegetation.
Spring Lake Peninsula	5	300	Dredging, island construction	Water quality Fishery	The structure did reduce velocities in the upper end of Spring Lake. Over-wintering fish response has been limited. Future project will further reduce velocities in project area
Trempealeau National Wildlife Refuge	6	5,600	Water control structures, dredging, interior dike construction	Water quality Vegetation	Construction was completed fall of 1999. First operation of the structures for water level management will begin in 2000
Long Lake	7	15	Water control structure	Water quality Fishery	Construction will be complete winter of 1999-2000.
Lake Onalaska Islands and Dredge Cuts	7	7,000	Dredging, island construction	Water quality Wildlife	Although not specifically being monitored, fisheries response to the project has been good based on reported harvests and observation of anglers. Waterfowl nesting use of the islands continues to increase.
I-90 Bay and East Channel	8	100	Bank stabilization, island construction	Fishery	Target fish present in I-90 bay. Assessment of response continuing.
Pool 8 Islands Phase I	8	1,000	Dredging, island construction	Water quality Vegetation Bathymetry Wildlife	Aquatic vegetation response to project is good. Waterfowl nesting limited due to high water events and size of main island.
Pool 8 Islands Phase II	8	600	Dredging, island construction	Water quality Fishery Vegetation Bathymetry	Target water quality parameters for over-wintering centrarchids met. Vegetation response better than expected. Fish response being monitored.
Blackhawk Park	9	420	Dredging and culvert installation to provide oxygenated flows	Water quality Fishery	Low dissolved oxygen problems alleviated through introduction of flow into backwaters. Fish response good.
Pool 9 Islands	9	350	Rock island construction	Vegetation	Within 3 years of construction, almost the entire area within the island complex is vegetated with submersed vegetation.
Cold Springs	9	35	Weir structure and dredging	Water quality Fishery	Low dissolved oxygen events have been alleviated in the southern lobe. Fish response good.
Bank Stabilization	7, 8, 9, 10	2,000	Shoreline protection		A variety of rock protection designs have stabilized over 5,000 feet of shoreline.
Bertom and McCartney Lakes	11	2361	Riverine "habitat" channel, island construction, dredging	Water quality Fishery Wildlife	Low dissolved oxygen in summer and winter alleviated. Fisheries response good and still being assessed. Ten-acre wetland in interior of island receiving heavy wildlife use.

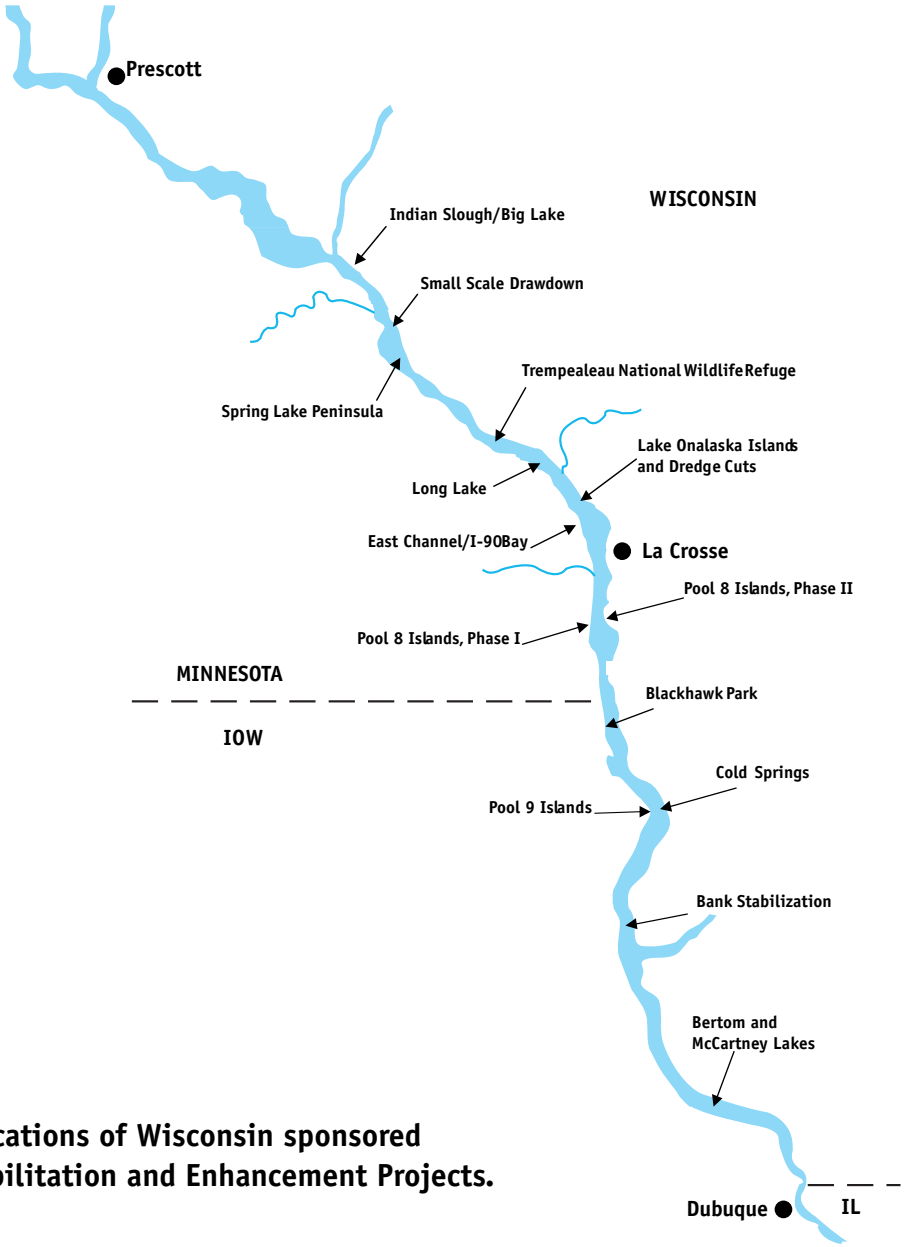


Figure 16. Locations of Wisconsin sponsored Habitat Rehabilitation and Enhancement Projects.

Navigation System Study

The Corps of Engineers from Vicksburg, Mississippi is in the sixth year of a Feasibility Study to determine the economic and environmental impact to the nation of increasing the capacity for commercial navigation traffic on the Upper Mississippi River System and the Illinois Waterway System. An Environmental Impact Statement (EIS) is required for this study. As part of this study, the Corps has created a model to determine if increased sediment will be delivered to off-channel areas due to increased traffic along the Mississippi and Illinois Rivers. Using a broad habitat classification system the model predicted that there are eight areas along the Wisconsin border that may see increased sedimentation of 0.1 to 1.0 cm/year associated with increased commercial navigation.

The WDNR is concerned with the lack of information that was available to run the model. The Corps of Engineers acquired sediment data along the main channel every mile and used basic land/water maps to determine areas of sediment delivery. The model was also run on a

very simplistic classification of habitat types. This clumping ignored important features like impounded areas and incorrectly classified secondary channels and backwaters. The WDNR is concerned with using the information generated from the model as a credible prediction of sediment delivery to the off-channel areas of the Upper Mississippi River. The result of this and other environmental studies will be published for public comment through the EIS next summer. The WDNR has expressed these concerns to the Corps of Engineers and will provide comment in our response to the EIS.

Wisconsin River

The Wisconsin River is the longest river within Wisconsin. Its waters support important municipal, industrial, recreational, and ecological values. The river has been highly modified by human activities over the last 150 years. Much of the river has been dammed for power production and flood control. Cities and industries have long discharged wastes into the river, and by the 1950s the middle and upper parts of the river were severely polluted. Beginning in the early 1970s, massive water treatment programs were initiated to improve river water quality.

Fishery Survey Results

During 1996-99, WDNR conducted a survey of the fish communities of the Wisconsin River in order to assess the ecological "health" of the river ecosystem. Standardized one-mile long daytime boat electrofishing samples were collected from 55 riverine locations from the mouth to the Vilas County border at river mile 375. The data from the Wisconsin River and other rivers in the state are being used by the WDNR to develop a large river index of biotic integrity for Wisconsin.

The Lower Wisconsin River supports one of the healthiest large-river fish communities in the midwestern U.S.

Preliminary analyses of the 1996-99 fisheries data indicate that the environmental quality in the Wisconsin River has improved substantially from the low point of the 1950s and 1960s. Areas that were grossly polluted and supported few fish as recently as the 1970s now have diverse communities of 10 to 15 species. Included in these communities are game fishes such as northern pike, walleye, and smallmouth bass and sensitive non-game fishes such as redhorse and darters. The Lower Wisconsin River below the Prairie du Sac Dam (river mile 92), which has always been the least degraded reach of the river, supports one of the healthiest large-river fish communities in the midwestern U.S. The river has high species diversity (15-25 species per sample) and contains rare species such as lake sturgeon, paddlefish, blue sucker, and crystal darter.

The most important remaining human impacts on the Wisconsin River come from dams. The Prairie du Sac Dam is a barrier to upstream movement, and at least 15 species are found only below the dam despite suitable habitat upstream. From Castle Rock Dam (river mile 159) to Wausau (river mile 265) almost no riverine habitat remains. The river is merely a series of contiguous impoundments. Fish communities in this area have relatively few sensitive species or riverine specialists and are often dominated by carp, a highly tolerant and adaptable exotic species. Above Wausau, some unimpounded reaches remain and carp are largely absent, but communities still have reduced numbers of riverine species.

Water quality improvements in the Wisconsin River have led to a recovery in fish communities, and by implication, a major improvement in overall ecosystem health. However, the large number of dams and impoundments that remain hampers further improvements in river health. The lower Wisconsin River, unfettered by dams, provides a vision of how the fish community of the rest of the river might look if the dams were not present.

Water & Sediment Quality & Toxic Assessments

The section of the Wisconsin River between Rhinelander and Grandfather Dam was remodeled in 1999 for wasteload allocations. This was done in response to the water quality violations for dissolved oxygen above Hat Rapids Dam. Preliminary results indicate that point source dischargers in the reach may not be a major contributor to the cause of the low dissolved oxygen levels. As a result, the study has been expanded to determine pollutant sources above Rhinelander as part of a TMDL approach.

Sediment quality continues to be monitored to assess background conditions and to assess areas of contamination. Sediment samples were collected at the following locations:

- Rhinelander Flowage (2 samples),
- Between Hat Rapids Dam and Kings Dam on Lake Alice (18 samples), and
- Wisconsin River below Castle Rock Dam (4 samples).

WDNR continues to track PCBs and dioxin in fish from the flowages. Another study evaluated the fate and transport of these contaminants. A carp population estimate was completed for the purpose of determining options for controlling the excessive carp population. A water quality model, known as BATHTUB, was conducted on the Petenwell Flowage and completed in May 2000.

During the reporting period, an eagle/osprey study compared reproductive success between raptors from Petenwell and Castle Rock Flowages with the Rainbow Flowage (control). The levels of PCB and dioxin were high in Petenwell and Castle Rock eagles and osprey, but information suggests that reproductive success is no different. However, the study did reveal that the growth and development rates of the young osprey from Petenwell and Castle Rock Flowages are different from osprey in the Rainbow Flowage.

Dam Removal and Abandonment

Dams have a significant impact on state rivers. They can cause water level fluctuations, changes in water temperature and oxygen levels, and act as a barrier behind which sediments settle and beyond which fish can not easily migrate, and draw fish into the turbines.

There are over 3,500 dams on Wisconsin waterways, with the highest concentrations in the western and northern regions. Approximately 1,130 of them are classified as large dams, meaning they are over six feet high and impound more than 50 acre-feet of water or they are over 25 feet high and impound more than 15 acre-feet of water. If these dams fail, they can cause loss of life or significant property or environmental damage.

Dams can have negative impacts on the water quality, habitat and biodiversity of riverine systems.

Under Chapter 31 of the state statutes, the WDNR has the vested responsibility of regulation of dams. The authority under Chapter 31 includes approval of plans for dams, alteration or additions to an existing structure and removal of a dam. Chapter 31 requires the owner of a dam to operate and maintain their dam in a safe condition. The owner can initiate repair, reconstruction or removal actions. However, it is more frequently the result of a failure or the result of a WDNR inspection that finds significant defects requiring major repairs to correct.

The decision to remove a dam is primarily an economic based decision made by the owner of the dam. Dam removal, which requires WDNR approval, must follow specific guidelines to assure protection of life, health and property, as well as the surrounding environment. Chapter 31 requires the WDNR to inspect all of the large dams in the state at least once every 10 years.

In the last 20 years, over 30 dams have been removed from the state's waterways. Most of these were economic based decisions made by the dam's owner or were abandoned dams where a responsible owner could not be found. There is a growing awareness, within the WDNR and outside the agency, of the negative affects dams can have on riverine ecosystems. Where dams have been removed, significant improvements have been noted in water quality, habitat and biodiversity at many of these sites. The WDNR has been more proactive in recent years discussing the potential habitat and water quality benefits associated with dam removal at public meetings or during discussions with dam owners faced with making decisions to either repair or remove dams. Integrated watershed plans provide recommendations on which water systems would improve if a dam is removed and which dams are most detrimental to the ecosystem. In selected cases, the WDNR has worked with outside partners to advocate for the removal of a dam or helped establish financial incentives to facilitate removal.

Many dams in Wisconsin do serve useful purposes, ranging from the generation of power to supporting recreational opportunities. Responsible individuals or municipalities own the vast majority of these dams. When faced with a decision to repair or reconstruct a dam, owners are always provided with a range of options, including removal. The WDNR does not issue orders to remove a dam in situations where owners have wanted to repair a failing structure and have the financial capability to do so. In selected cases the WDNR has advocated for the removal of a dam or helped establish financial incentives to facilitate removal.

The following are some examples of communities who have or will reap significant benefits by making the difficult decision to remove the dam when dealing with the safety issues related to the age and condition of the structure.

Woolen Mills Dam

The Woolen Mills dam was one of 56 dams built on the Milwaukee River for mechanical or hydropower generation. It stopped producing power in 1956 and was sold to the City of West Bend. When the Army Corps of Engineers inspected the dam in 1980, the structure was considered a high hazard and was so deteriorated that the only rehabilitation option was total reconstruction. The combination dam/bridge replacement was estimated to cost $3.3 million.

Local residents favored reconstruction thinking that the impoundment enhanced property values, provided a scenic viewscape and helped contain contaminated sediments. The WDNR supported dam removal, because the impoundment provided poor water quality and limited recreational use. The sediments were being contaminated with heavy metal laden seepage from an adjacent landfill. Stunted carp and white suckers were the predominant fish species. After initially committing to reconstruct the dam, the City Council decided in 1988 to remove the dam and restore the impoundment area.

The WDNR used an integrated resource management approach to bring financial assistance from multiple programs to aid restoration efforts.

- Priority watershed funds paid for 70% of seeding and stabilization of the impoundment and 50% of design and engineering services.
- Fishery Management spent $68,000 improving fish habitat in the river by narrowing the channel and installing in-stream habitat structures.
- Stewardship funds provided 50% of the funds for park improvements including a canoe launch, trails, pedestrian bridges, athletic fields, riverbank fishing access, and parking.

All totaled the structural removal of the dam cost just over $68,000. More than $1 million has been spent by the city and state to restore the former impoundment area.

Removing the Woolen Mills Dam has provided environmental, recreational and financial benefits to West Bend and the surrounding area. This part of the river now supports popular game fish such as smallmouth bass, northern pike and rock bass. Dam removal has improved water quality by restoring the natural ability of the river to add oxygen to the water and separating the river from contamination sources. Sixty acres of land have been added to the City's Riverside Park including athletic fields and a large natural area planted with wetland and prairie species. Trails through this area are popular for walking and biking and provide a link to the City's Riverfront Parkway trail system. The project benefited the City of West Bend by removing the liability and expense of operating and maintaining the old dam. The expanded city park has also increased the value of neighboring properties.

North Avenue Dam

The North Avenue Dam is located on the Milwaukee River 3.2 miles upstream from its confluence with Lake Michigan. Since it was constructed in 1835, the 17-foot high dam has formed an artificial boundary between the Milwaukee River and the Milwaukee Estuary. The resulting impoundment was approximately 81 acres in size. The dam was constructed originally to create a barge canal between the City of Milwaukee and Fort Atkinson on the Rock River, but the canal was never completed.

Removal of the North Avenue Dam on the Milwaukee River is expected to benefit the recreational sport fishery and enhance recreational opportunities in the environmental corridor.

Over time, water quality in the impoundment became severely degraded and the biological and recreational uses became very limited. Water-based recreational uses, aquatic life and wildlife habitat were limited by low dissolved oxygen levels, elevated levels of turbidity, algae, temperature, and bacteria, and deposition of contaminated sediments. The sediments in the impoundment were moderately polluted with PCBs, PAHs, heavy metals and oxygen demanding materials. Fish and other aquatic life were dominated by very tolerant species because of the degraded environmental quality.

A feasibility study was initiated in 1992 to address the degraded water quality and recommend alternatives to manage the lower river and dam, enhance recreational opportunities, and cleanup the contaminated sediments. Partial dam removal with sediment and river management was identified as the recommended alternative. A community partnership, including the City of Milwaukee Metropolitan Sewerage District, the Southeast Wisconsin Regional Planning Commission and WDNR, provided direction for the project.

The dam was partially removed during the fall-winter of 1997-98. Contaminated sediments were capped on site and protected from future erosion. In-stream habitat structures were also added. The City obtained land and easements necessary to expand their riverwalk through the project area to connect with the Milwaukee County trail system. A variety of other river restoration projects were implemented. To date, the project costs have been $4.5 million, which pale in comparison to the other alternatives estimated at $18-80 million. The WDNR, U.S. EPA grants and the City of Milwaukee provided the majority of funds. The dam removal has received good public acceptance. Additionally, 750,000 cubic yards of contaminated sediments have been effectively contained.

Some of the expected benefits of this project include:

- Create a recreational sport fishery unique to southeastern Wisconsin, including trout and salmon, smallmouth bass and occasional walleye.
- Minimize or eliminate the movement of contaminants in the former impoundment and the Milwaukee River Estuary through the cost-effective management of 750,000 cubic yards of contaminated sediment.
- Provide a link with the downtown Riverwalk and enhance public access and recreational use opportunities along the environmental corridor including trails, scenic overlooks, fishing and canoe access.

Figure 17. Number of native species vs. total species captured.

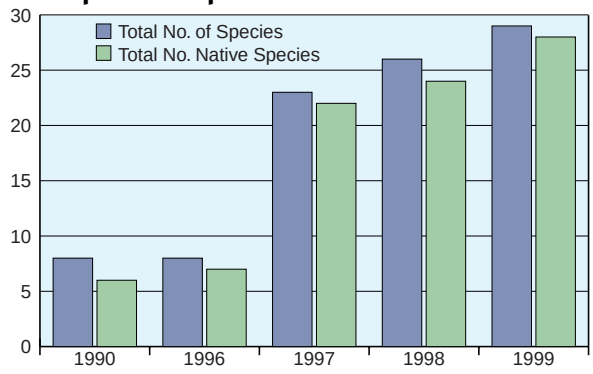
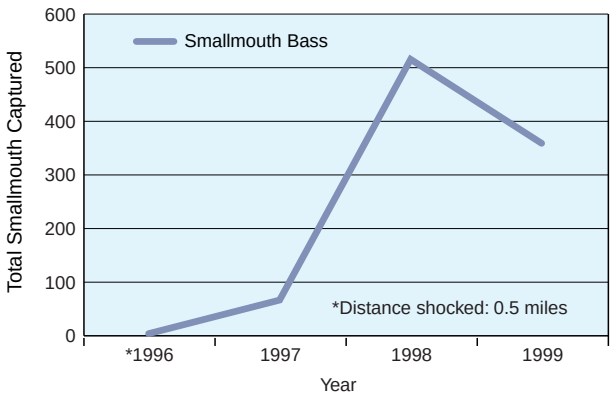


Figure 18. Total smallmouth bass captured.



- Restore the biological and recreation impaired uses of the Milwaukee River and its estuary; provide the opportunity for local, state and federal governments, private land owners, conservation and other interested groups to work together.
- Eliminate the navigation barrier for resident and anadromous fish, and restore fish and aquatic life habitat.
- Create 32 acres of floodplain wildlife habitat including wetlands.
- Improve overall water quality, particularly along the former impoundment and upper Milwaukee River Estuary reaches. While the data collection efforts are still ongoing, the biological response to this project has been favorable. In 1990, the fish community in the former impoundment was dominated by six species considered tolerant to very tolerant of degraded environmental conditions. Following dam removal in 1997, the number of native fish species increased 5-fold. The representative species are less tolerant of degraded environmental conditions (refer to Figure 17). Smallmouth bass are the dominant species and the Greater Redhorse, a state listed threatened species, is common (refer to Figure 18). Under suitable flow conditions, trout and salmon have migrated approximately 30 miles upstream to the Village of Grafton on the Milwaukee River and the City of Cedarburg on Cedar Creek.

Baraboo River Dams

This project involves removing the last four remaining dams on the 74-mile, main stem of the Baraboo River. The dams on the river were built as mill dams in the mid-1800s. Over time, the dams have lost most of their functional value and the impoundments suffer from impaired water quality. Originally 5 dams were constructed to harness the energy from the 50-foot hydraulic drop of the river through the City of Baraboo. As of 1996, the Oak Street Dam, the Waterworks Dam and Linen Mills Dam still blocked the river in Baraboo, drowning out most of the Baraboo rapids section of the river, degrading the water quality and blocking fish migration. Further upstream in LaValle, the old milldam still blocks the river and produces a small bit of power.

The objective of the project is to complete removal of the dams, restore and enhance aquatic habitat, and restore and enhance riparian habitat and wetlands. Removing the dams in Baraboo will reconnect the Baraboo River with the complex Wisconsin River fishery. There are currently 10 species found below the dams that are not present in the upstream system. The City of Baraboo will use the dam removal opportunity to develop a riverwalk system and revitalize the rundown river front area.

To date, the Waterworks dam has been removed. The two other dams have been purchased from their private owner and plans are being made to remove the structures over the next five years. A private foundation has the option to purchase the LaValle Dam and discussions have just begun with the community, laying the foundation for the dam removal project. The first removal was not accomplished without significant public debate and strong sentiment expressed for reconstruction of the dam. However, many interests are now joining together to plan and implement the final project that will address a wide variety of resource, social and economic needs. Some of the many partners in these projects include the City of Baraboo, the WDNR, the Army Corps of Engineers, UW-Extension, UW-Center for Limnology, UW-Stevens Point, Sauk County, the River Alliance of Wisconsin, and the Sand County Foundation. Monitoring programs are being established that will measure the effects of the projects.

Dam Relicensing

The Federal Energy Regulatory Commission (FERC) is responsible for licensing most of the state's hydropower plants, and they review the 30 to 50 year leases to ensure that they meet federal regulations for safety and resource protection. As the original licenses expire, dam owners are required to:

- consult with WDNR, U.S. Fish and Wildlife Service, other resource agencies and local citizens;
- conduct studies to identify environmental effects of dam operation; and
- develop plans that will minimize environmental effects.

FERC's role is to give proper consideration of WDNR and other resource agencies comments and requirements and balance economic and environmental concerns when issuing new licenses.

Wisconsin has had a considerable number of FERC licenses expire during the last eight years. Of the 43 licenses that have expired in that time period, only a few of them have received new licenses. The majority of the rest of the projects with expired licenses are operating under interim annual licenses until FERC completes its review. An additional 18 projects in the state have licenses that will expire in the next five years.

In some cases, dam removal is the preferred option instead of relicensing. Often, these are smaller dams with poorer economics or ones that may require extensive repairs for safety reasons. Removing dams can significantly improve the quality of fisheries both upstream and downstream of these sites. Two dams are tentatively scheduled for dam removal as part of a pending federal hydropower licensing agreement covering a number of dams in the Menominee River basin in Florence County. As part of the agreement, Wisconsin Electric would agree to remove the Pine Dam on the Pine River if requested to do so by the WDNR when its license expires in 25 years. The Woods Creek Dam would be removed when the federal licensing agreement is approved. Refer to the preceding section on Dam Removal and Abandonment for information on selected dam removal projects at sites not subject to federal licensing.

Recent federal court cases have clarified the power states have on dam relicensing under Section 401 of the Clean Water Act on Water Quality Certification. Based on these rulings, Wisconsin has become more aggressive in using its authority under Section 401 to address environmental concerns.

Lakes Assessment

Protecting In Partnership Our Legacy of Lakes

The Wisconsin Lakes Partnership is entrusted with protecting and restoring the state's lakes and their ecosystems.

All of Wisconsin's 15,057 inland lakes are considered a significant public resource. The great variety of lake types makes management a challenge. Lakes range in depth from a few feet to 236 feet (Big Green, Green Lake County), from small ponds to 137,708 acres (Lake Winnebago, Winnebago County), and from clear soft water lakes to hard water lakes prone to intensive algal growth.

Wisconsin's Lake Management Program combines monitoring and water quality assessment, research, and community financial, organizational, educational and technical assistance. The purpose is to plan, protect and restore the state's lakes and their ecosystems in partnership with other agencies and citizens. The Wisconsin Lakes Partnership is a team of WDNR and University of Wisconsin-Extension staff and citizens represented by the Wisconsin Association of Lakes, who bring technical expertise, outreach and stakeholder concerns together to focus on the state's lakes. For more detail on the individual aspects of the Lake Management Partnership, please consult the 1994 Water Quality Assessment Report to Congress.

In 1996, the WDNR reported on an emerging trend toward greater county and local leadership in lake management. In the last five years, this trend has become a key element of Wisconsin's lake management efforts largely facilitated by the state's Lake Planning and Protection Grants. Since 1990, hundreds of grants have been awarded for projects that touch on all the Partnership's functions. The assessment and management information generated by these projects now provides an opportunity for adding a considerable amount of new information for this report.

Lakes Assessment

Assessment of lakes for the 305(b) report is an integral component of Wisconsin's overall Watershed Management Program. For past 305 (b) reports, WDNR regional staff has updated the lake information in the watershed tables of the water quality basin plans, which was incorporated into the U.S. EPA Waterbody System. The lake data in that system was then downloaded to U.S. EPA to meet the reporting requirements for the 305(b) report. As explained in the "Rivers and Streams Assessment Section," U.S. EPA recently improved the waterbody system and sent Wisconsin a copy of that database in the summer of 1999. The WDNR received the database too late to verify and update the lake information for this 305(b) report. Due to the changes in databases and reporting format, the Lake Water Quality Assessment information will be provided to U.S. EPA electronically by April, 2001 as previously agreed to by staff from WDNR and EPA Region V.

To characterize the condition of Wisconsin's lakes for this report, the WDNR has completed two analyses. The first one is a summary of the trophic status for all lakes for which data was available from 1994-99, and the second one is a summary of the trend in water quality of 50 lakes the WDNR has been monitoring intensively over an eleven year period.

Trophic Status of Wisconsin Lakes

WDNR staff compiled data from 1995-99 and determined an average trophic state index (TSI) (using Carlson's methodology) for 701 lakes that were monitored for Secchi disk (clarity), cholorphyll-a (algae) and total phosphorus (nutrients). The results are shown in Table 11. This data represents more than half of Wisconsin's total inland lake surface acreage. Over half of the waters listed in Table 11 exhibit what is consider to be good to excellent water quality (oligotrophic and mesotrophic conditions). In fact, on 650 lakes, the local self-help volunteer monitor was asked to subjectively assess the quality of their lake on a scale of one to five with one representing excellent and five representing very poor. The average response was two.

Table 11. Trophic State of Lakes (2000 Assessment)

Trophic State	No.	Acres
Oligotrophic	138	54,685
Mesotrophic	429	208,556
Eutrophic	112	251,630
Hypereutrophic	22	40,453
Total Assessed	701	555,324
State Total Lakes	15,057	982,155

Long-term Trend Lakes Analysis (1986-96)

Eleven years of data from 50 lakes was collected and analyzed to examine trends in nutrients (measured by the phosphorus concentration), the amount of algae (measured by Chlorophyll-a concentrations), and water clarity (as determined from the Secchi disk depth). Figure 19 shows the location of the 50 long-term lakes. The Long-term Trends (LTT) (also called Ambient Monitoring) program began in 1986 and continues presently although with some modifications to protocol. Because these lakes range among type, quality, location and watershed conditions, they may be used as an indicator of the trend in the state's overall lake conditions.

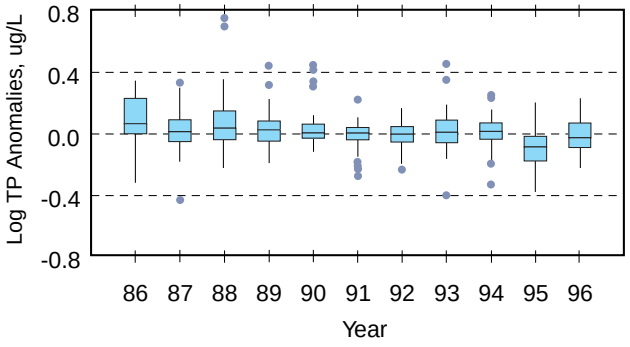
As a group, there is no apparent long-term trend over 11 years (refer to Figure 20). However, eighteen of the 50 lakes show significant trends in one or more trophic variables (Table 12). A majority of these trends were for declines in total phosphorus (TP) and chlorophyll a (Chla) while only one lake shows increases for Chla and two for TP. Secchi disk trends were evenly distributed among increasing (4) and decreasing (5) values. Thunder Lake, a large shallow lake, underwent the largest shift in trophic state, representing a possible stable state shift in dominance from a turbid water algal community to a clear water rooted plant community.

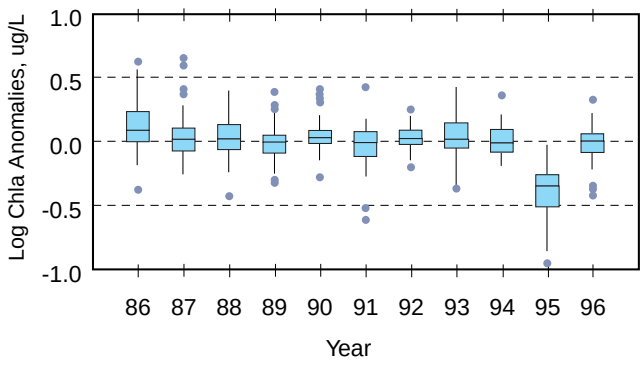
The 1995 pattern of lower Chla and TP and higher Secchi is striking. The summer mean Chla concentrations are lower by up to an order of magnitude compared to 1988, a drought year. Consistent, but less extreme decreases in TP and increases in Secchi depth are also apparent. The uniformity of the 1995 response across a set of 50 widespread and diverse lakes suggests the climate influenced the results and not human disturbance.

While not a perfect surrogate for the state's lakes, this analysis indicates stable if not improving lake conditions. For more information on this study and its methods see Webster, K.E. 1998. Responses of lakes to drought: geomorphic and landscape controls. Ph.D. thesis, University of Wisconsin, Madison. 179 p.

Figure 19. Locaton of 50 Long-Term Trends Lakes.

Figure 20. Annual anomalies (difference from 11-year mean) for log TP, log Chl*a*, and Secchi disk transparency for the LTT lakes grouped by year (Thunder Lake omitted).





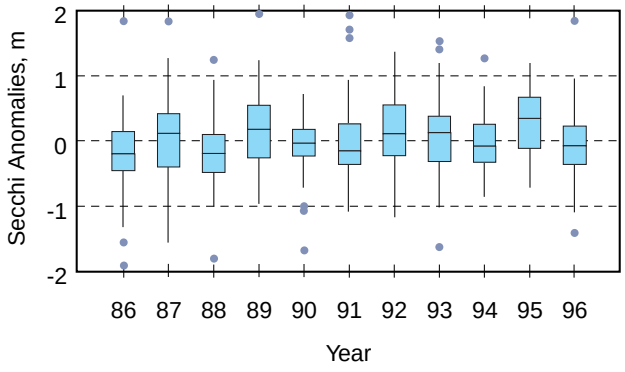


Table 12. Long Term Trend lakes with significant trends. Slopes are the median slopes; p is the significance level.

Region	Lake Name	Chla(ug L-1 yr-1)		Secchi (m yr-1)		TP (ug L-1 yr-1)	
		Slope	p	Slope	p	Slope	p
NER	Big Long	-5.8	0.008	0.06	0.004		
	Clark			-0.11	0.018	-0.4	0.003
	Keyes			-0.08	0.038		
	Lost			-0.14	0.045	0.3	0.045
	Silver					-4.6	0.040
NOR	Kentuck	-2.2	0.028	0.19	0.020	-2.8	0.017
	Minocqua					-0.5	0.038
	Thunder	-10.6	0.0002	0.07	0.002	-12.2	0.001
	L. Eau Claire					-0.4	0.045
	Silver			-0.15	0.027		
	U. Eau Claire			-0.11	0.038		
SCR	Rock	-0.4	0.007	0.13	0.046		
SER	Big Cedar					-0.5	0.042
	Browns					-0.5	0.006
	Nagawicka					-0.5	0.028
	Whitewater	-1.7	0.025				
WCR	Cedar					4.12	0.033
	Squaw	4.6	0.034				

Clean Lakes Program Activities

Wisconsin has traditionally had a strong partnership with the U.S.EPA in the protection of the state's lake resources. This partnership was severely eroded in 1995 when EPA did not seek funding for the Clean Lakes Program (section 314 of the Clean Water Act). With the loss of federal funding, involvement in lake planning (Phase I), lake protection and restoration (Phase II) and lake project evaluation (Phase III) diminished and no new projects were initiated. Activities were limited to completion and close out of the following projects:

Fish Lake Phase I
Lake Wissota Phase I
Lake Mendota Phase I
Bass Lake Phase II
Delavan Lake Phase II
Lake Comus Restoration Phase II
Wind Lake Phase II
Devils Lake Phase III
Delavan Wetland Evaluation Phase III

The lack of federal Clean Lake funds also eliminated Wisconsin's Lake Water Quality Assessment Program. Without statewide lake assessment, Wisconsin lakes were virtually eliminated from the state's Water Quality Report to Congress (section 305b), Listing of Impaired or Threatened Waters (section 303d) and from the state's restoration programs funded under the Clean Water Act including Nonpoint Source Pollution Abatement and TMDL programs.

U.S. EPA's renewed interest has helped in reestablishing its partnerships with state lake management programs. In 1998, U.S. EPA amended its guidance for administering Nonpoint Source Pollution Abatement Program (section 319) to include all Clean Lake Program Activities. The WDNR amended its work plan under section 319 to make these activities eligible. However, without an increase in federal funding, no money was available to support Clean Lake Program activities within the state.

In 1999, U.S. EPA provided incremental funding to states in addition to base grants. This incremental funding allowed Wisconsin to once again fund Clean Lake Program activities. The WDNR reestablished the state's Lake Water Quality Assessment Program, including lake monitoring and reporting. The goal is to target future funds for Phase I and II projects. Increased funding under section 319 or full funding under section 314 of the Clean Water Act would allow the Clean Lake Program activities to continue.

The Lake Management Program

In cooperation with the University of Wisconsin-Extension (UWEX), WDNR lake specialists have developed literature for waterfront landowners and citizens interested in lake water quality and ecosystem protection. Premiere publications such as *Life on the Edge….Owning Waterfront Property*, and *Through the Looking Glass…. A Field Guide to Aquatic Plants* are extremely popular and distributed nationwide. Since 1995 a series of websites linking the WDNR, UWEX, Wisconsin Association of Lakes (WAL) and the North American Lakes Management Society has been established. Previously printed media and fact sheets are being converted for distribution via the web, and all new materials are available in this format as well. In addition, a slide show titled Margin of Error, highlighting the potential impacts of lake shore development on lakes, was widely distributed for educational efforts to WDNR staff, local units of government and lake organizations. Other publications include a new fact sheet series on the importance of vegetative buffers along lake shorelines and streams, a technical Guide to County Lake Classification, a 24 fact sheet series on lake classification issues and strategies, and a monthly newsletter called 'Water and Law.'

Organization and education assistance was expanded in 1997. With the creation of funding and authority, it allowed the WDNR to contract with an outside organization for statewide education and technical assistance on lake classification. In 1999 a contract was awarded to WAL, which supports two new full time employees for that organization. These positions are being used to improve communication and coordination among lake organizations within counties. Projects include shoreland development, zoning and lake classification and assistance in developing and delivering the appropriate educational and technical materials and programs.

In 1995, Adopt-A-Lake was established through UWEX to give both youth and adults a better understanding of aquatic ecosystems through the promotion of hands-on activities. To ensure a supply of lake leadership at the local level, the Lake Leaders Institute was established in 1999. This program provides citizens with the opportunity to attend three, two-day seminars on environmental philosophy, ethics, limnology, politics and government functions. In exchange, they have a personal commitment to apply this knowledge by becoming advocates for lake stewardship.

Self-help Citizen Lake Monitoring

Wisconsin's Lake Partnership sustains a number of on-going activities to provide the knowledge and understanding for citizen lake leaders. They include the Wisconsin Lake Convention which is attended by over 700 people annually, the newsletter Lake Tides which is read by over 20,000 subscribers, and a series of fall workshops hosted by the Wisconsin Association of Lakes on topical issues.

Self-help volunteers assist in data collection efforts on lakes.

Wisconsin's Lake Partnership nurtures public involvement. High quality monitoring data supports sound management. WDNR relies on the public to gather much of the data. The number of volunteers involved in self-help Lake Monitoring continues to expand, as have the breadth of monitored parameters, and the number of sites monitored. Almost 1,000 volunteers participate in a wide variety of monitoring activities including measuring water clarity, chemistry, aquatic plants, and monitoring for the spread of invasive species such as Eurasian watermilfoil and zebra mussels. Volunteer monitoring is the state's largest single source of trophic state information.

Since 1995, interest in participation exceeded WDNR's financial and data management capabilities resulting in a "freeze" in program growth until solutions could be found. In 1996, a phone-in system replaced mail cards as a more efficient method of reporting data. Updates in data management software helped maintain the steady increase of volunteer involvement in Secchi disk monitoring. Recently, grant funding has facilitated growth in the chemistry-monitoring program. New equipment provides citizen volunteers easier and more accurate ways to collect data. Reporting data will soon be facilitated electronically in addition to the current phone-in system. Self-help Lake Monitoring data will be comparable to other baseline monitoring programs statewide and nationally.

Aquatic Plant Management

Nuisance aquatic plants can limit aesthetic and recreational enjoyment of lakes and replace beneficial native plants that provide food and cover for fish and other wildlife. The aquatic plant management program identifies sensitive areas for protection that provide critical or unique fish and wildlife habitat. Permits for chemical treatment are allowed only to alleviate severe problems in specific areas.

Lake Protection and Restoration

WDNR's Lake Planning and Protection Grants have a major and diverse impact on the management of the state's lakes. These grants, which are 75% state cost-shared, are at the core of the partnership between state and local entities that are striving to protect and restore lakes and their ecosystems. Currently, $2.6 million is available annually to support a balance of locally-initiated projects ranging from monitoring, data collection, and development of lake management plans to land acquisition, local ordinance development, restoration projects, and implementation of watershed best-management practices or activities identified as part of a management plan (refer to Table 13).

Table 13. Summary of Planning and Protection Grant Activity from 1989 to 1999.

Project Type	No. Lakes	Surface Acres	Grants Awarded	$ Awarded
Totals			868	$16,888,148
Lake Planning	100	367,321	722	$6,054,626
Lake Protection				
Land Acquisition	38	64,250	61	$5,861,115
Watershed BMPs	14	12,350	16	$1,577,805
Diagnostic/Feasibility	8	54,915	8	$734,760
Wetland Restoration	5	16,634	5	$235,238
Classify/Ordinance	12,144	536,798	43	$1,880,293
Lake Restoration	13	6,188	13	$544,311

Lake Planning Grants

Over 100 lakes and lake-chains covering more than 367,000 acres have used state funding for lake planning. These efforts include conducting water quality assessments and watershed inventories, developing nutrient budgets, conducting education programs and writing management plans (refer to Table 13). These plans often become the basis for protection grant applications or other sources of funding and assistance.

Efforts are underway to revise and diversify Wisconsin Administrative Code NR 190 Lake Management Planning Grants program to allow for small-scale projects. Capped at $3,000, the grants will be expanded to increase volunteer chemistry monitoring, lake organization and education efforts. Large-scale grants of up to $10,000 will still be available. This will maintain a continued emphasis on comprehensive lake management plans while still allowing for a broader range of projects that will match the needs of different lake types.

Little Green Lake was one of the first lake districts to apply for planning assistance in the early 1990s. It is a highly eutrophic 466 acre lake in central Wisconsin with a long history of problems associated with nonpoint source pollution. A management plan was formulated after a series of grants studied the water quality, land use conditions, septic systems and aquatic plants. Working with the county land conservation department, best management practices are being installed in the watershed, an aeration system is being designed for installation in 2000, and plans for a sanitary sewer system and stormwater management are being developed. Monitoring has continued throughout the 1990s and small but steady improvements in lake-water quality are noted.

Lake Protection Grants

Lake Protection Grants provide up to $200,000 per grant for implementing projects that protect lakes and their ecosystems. Since 1994, one or more projects have taken place on 78 lakes and lake chains covering over 148,000 surface acres. The grants were used for land acquisition, wetland restoration, watershed best management practices or diagnostic and feasibility studies. Land acquisition has been the most popular use of these funds as the demand for lakeshore property has increased. Some 4,066 acres of natural shorelines, woodlands, wetlands and riparian land have been purchased to permanently protect the water quality, habitat and natural beauty.

Grants are used to implement projects designed to protect lakes and their ecosystems.

Guarding the Treasure - Two of Wisconsin's premiere lakes—Geneva Lake in Walworth County (5,262 acres and 135 feet deep) and Big Green Lake in Green Lake County (7,346 acres and 236 feet deep)—are the focus of protection efforts as part of the Lake Protection Grant Program. Each lake supports a two story fishery and are heavily used recreational lakes. To assure the long-term health of lakes, protection grants are being used to fund diagnostic and feasibility studies. These studies combine detailed water quality and land use

data with state of the art modeling to create comprehensive management plans. However, implementation does not depend on the completion of these studies. Concurrently, funding from the grants have been used to divert an urban storm sewer discharge from Geneva Lake, purchase 27 acres of sensitive land abutting Big Green Lake, and assist in the development of local stormwater management ordinances and public outreach and education efforts around both lakes. Such actions will help assure that these deep, clear water jewels can be enjoyed for generations to come.

Grants for Lake Classification & Ordinance Development

In 1997, Lake Classification Projects were added to the lake protection grant program. These grants provide funding to counties to "classify lakes by use and implement protection activities for the lakes based on their classification." This is a financial incentive program that does not provide counties with any expanded authority over the management of lakes. It allows counties to voluntarily classify lakes within the context of overall guidelines established by the WDNR.

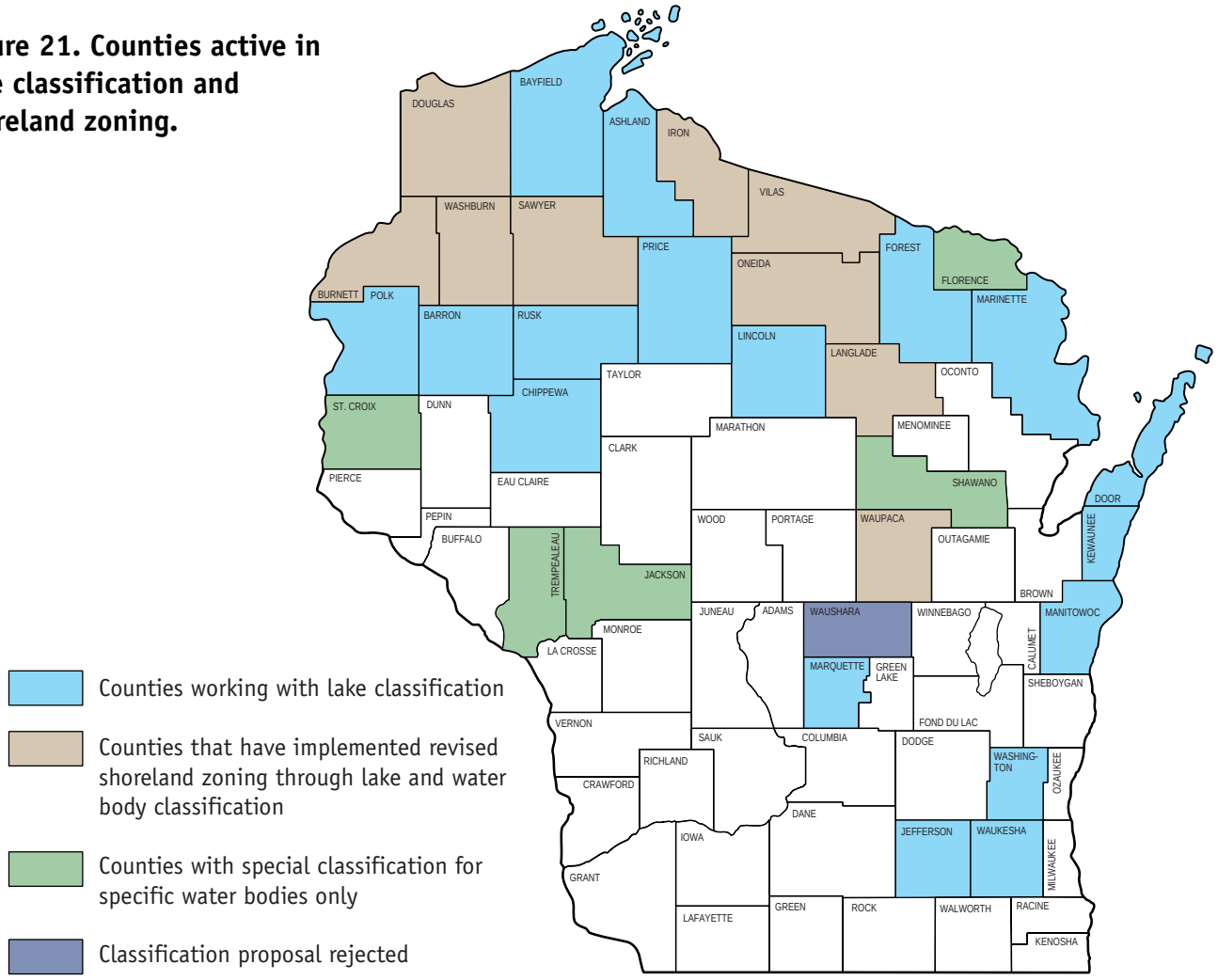
To date, 29 of the state's 72 counties have undertaken efforts that primarily facilitate improvements in shoreland zoning and management. In general, classification projects have applied a variation of the three-tier Minnesota classification system that ties greater development restrictions (deeper setbacks, larger lots) to waters that are more sensitive to the impacts from shoreland development. Generalized Lake Classifications include:

- **General Development Lakes:** These are lakes with a high to moderate existing development density. They are more tolerant of development and use impacts or are already so fully developed that changes to shoreland zoning will have minimal effects. These lakes are assigned the least restrictive set of standards, but not less than current state law. Management strategies for these lakes may include programs for restoring shoreland buffers and other ecosystem functions that have been lost.
- **Transitional or Intermediate Lakes:** This classification is a protection or conservation category for lakes with moderate shoreland and waterbody use. It is intended to prevent transition to higher development densities and uses that may be allowed under current state minimums. Recreationally, whole lake use restrictions may apply but more typically are best suited for categorical time of day, or area use specific zoning.
- **Natural Environment Lakes or Wild Lakes:** This classification category is intended to preserve and protect lakes from inappropriate or overly dense development and recreational use that can occur under current state standards. Shoreland management strategies include the most restrictive development standards and are good candidates for permanent protection measures such as purchasing easements or acquisition. Potential recreational strategies may include no wake or no motor restrictions.

The biggest impact of this program has been in northern Wisconsin. Virtually all the northern counties have enacted restrictions that protect smaller, less developed lakes from unrestricted development allowed on some larger lakes under current state minimum standards for shoreline development. With more than 12,400 lakes clustered in the northern part of the state, the impact of this initiative will have tremendous long- term benefits by protecting these waters from the ever growing pressure for shoreland development and recreational use. More than half of the lakes in some counties is in this most protected management category.

In addition to specific county classification grants, other units of local government can receive up to $50,000 to develop ordinances and conduct the land use planning. These efforts will protect lakes from the impacts of land development or establish boating or other environmental ordinances. In northern Wisconsin, many lake-rich townships have made use of these funds to develop water quality based land use plans to guide development and protect their extensive lake resources (refer to Figure 21).

Figure 21. Counties active in lake classification and shoreland zoning.



Special Lake Classification and Shoreland Protection Efforts in Burnett County—With over 500 named lakes, and 80% of its population living in the shoreland zone, Burnett County embarked on a comprehensive land use planning process including lake classification. The two-year effort resulted in several benefits. In 2000, a countywide program was cost-shared with the addition of protection grants. This program will provide technical assistance, incentive payments, tax credits and cost sharing of materials to protect and restore natural vegetative buffers along the county's lakes and streams. Once enrolled, these properties will be permanently protected through restrictive covenants. This is being funded as a pilot project and, if successful, may become the basis for yet another sub-category of lake grants.

Lake Restoration

A portion of the funds for lake protection grants is allocated to in-lake restoration projects. When the program was first developed, emphasis was placed on planning and protection over restoration. Recently, as more plans are in place and protection projects implemented, there has been a growing demand for restoration funds. Dredging, specifically, is not eligible although grants may be used to plan, analyze and support or complement dredging projects. Thirteen lakes have received over $500,000 in grants in the last five years for lake restoration.

Wappogasset, Beartrap and Bass Lake Alum Treatments - In 1999, three of these lakes were treated with alum through funding from a lake protection grant. In each case these lakes had

a long history of watershed nonpoint source loading that resulted in accumulated sediments rich in phosphorus. Each lake's watershed had undergone targeted and extensive nonpoint source management programs, which had brought nonpoint sources loading under control. However, internal nutrient cycling caused these lakes to maintain eutrophic conditions. Alum treatments, conducted in the fall of 1999, should result in greatly improved water quality in the coming open water season. These are great examples of integrated management combining watershed and in-lake restoration techniques that rewards diligent nonpoint source control efforts with dramatic improvements in the target resource.

Other Lake Program Activities

Shallow Lakes Initiative

Large shallow lakes represent management challenges uniquely different than deeper, more typical glacial lakes. Rough fish, exceedingly high nutrient concentrations, water level conflicts and limited management organizations (for sponsoring grants), motivated the WDNR to establish a dedicated source of funding for shallow lake management projects. This initiative was begun in 1995 and focused on implementing a restoration project on Big Muskego Lake. With the experience and techniques developed through funding this project, complex management issues on many other large shallow lakes in the state— Winnebago, Rush, and Fox Lakes—can be addressed.

Big Muskego/Wind Lake Restoration - Big Muskego Lake (2,236 acres) is a large shallow lake located in southeastern Wisconsin. Water quality problems, algal blooms and severe turbidity, have plagued the lake as a result of excessive carp populations, historical wastewater discharges and high internal loading. The high nutrient and sediment discharge from Big Muskego contributed about 70% of the external load to downstream Wind Lake (936 acres) resulting in similar problems. Several studies, concluding with a Section 314 Phase I project, led to the development of a restoration plan for both lakes.

In 1996, the Big Muskego/Wind Lake restoration project was initiated. It included an extensive one-year drawdown of the lake, fish eradication and restocking, vegetation management and watershed best management practices. This was followed by alum treatments at both Wind Lake and the deeper portion of Big Muskego known as Bass Bay. The restoration project has improved Big Muskego from a turbid, algal lake dominated by Eurasian water milfoil to a clear-water lake with a dominance of a variety of aquatic plants. Substantial improvements of the natural resource condition and lake use potential of Wind Lake has also been realized.

Restoration projects have substantially improved the condition in some lakes.

Rice Lake - Nearly destroyed by the discharge of poorly treated sewerage, this shallow 128-acre lake is coming back to life again. Beginning in the 1970s, the lake system crashed from years of abuse and was characterized as hypereutrophic with a mean total phosphorus level in 1982-83 of 430 ug/L and a water clarity reading of only inches. Treatment plant upgrades began in 1978 and have resulted in noticeable improvements. Water quality began to improve in the early 1990s. In 1999 a summer mean phosphorus level of 30 ug/L was recorded with clarity readings of up to five feet. The fisheries and the plant community have responded as well, and the lake is being used again as a recreational resource. Even wild rice has rebounded.

Additional treatment plant upgrades and continued improvements in the nonpoint controls in the watershed bode well for the future of the lake. The WDNR has plans to stock bass in 2000. As in many large shallow lake systems, an extensive wetland buffer system is probably responsible for the long lag times in seeing both declines and improvements in the lake condition.

Lake Modeling

The Wisconsin Lake Modeling Suite (WiLMS 3.0) model is a lake water quality-planning tool. It provides WDNR staff and consultants with a consistent tool— specific to fit conditions in Wisconsin— for analyzing current and predicted lake water quality conditions. The model uses an annual time step and predicts spring turnover, the mean growing season and annual total phosphorus concentration in lakes. WiLMS uses average annual export values by land cover type in its watershed-loading module to estimate annual loading. Lake and reservoir total phosphorus concentration is predicted using 13 empirical lake response regressions. WiLMS includes an uncertainty analysis module used to predict water column total phosphorus prediction uncertainty and a trophic response module to predict water-column trophic condition. WiLMS was recently upgraded to run on Windows NT and other 32 bit systems and also contain extensive on-line help. A revised user manual is currently under development.

Great Lakes

Much of Wisconsin's Great Lakes shoreline is rugged and scenic.

Wisconsin is fortunate to have 1,017 miles of Great Lakes shoreline, a vast reservoir of fresh water. Much of the special character of Wisconsin can be attributed to rugged and scenic Great Lakes Shoreline. It has inspired artists' enclaves in places like Door County—called the New England of the Midwest; exceptional recreational opportunities allowing for activities from yachting to ice fishing, and a history of commercial fishing and shipping that has provided the unique character for many communities. About a third of our state's 11 million acres of land, and 10,122 river miles, drain to our two bordering Great Lakes, Superior and Michigan. And along this shoreline resides the highest density of our urban populations and the majority of the state's industrial base.

Wisconsin has long recognized the uniqueness of our Great Lakes resources and established criteria to help protect the waters draining from Wisconsin into the Great Lakes. In partnership with other states and national and international efforts, Wisconsin has committed significant resources to help protect and restore the water quality of all the Great Lakes.

Lake Michigan

Lake Michigan, the second largest of the Great Lakes, covers 22,300 square miles and has a retention time of 99 years. It is the only Great Lake entirely within the borders of the United States. Lake Michigan is an important national resource supplying drinking water for 10 million people, providing important sport and recreational fishing opportunities and valuable recreational uses. It has also experienced profound changes in its aquatic ecosystem over the last 140 years and is threatened by toxic pollutants that bioaccumulate in the food chain and persist in the environment. Lake Michigan is a system under stress due to loss of fish and wildlife habitat, a decline in biological diversity and the introduction of invasive species. Efforts are underway to address these problems. Through the RAPs and LaMP, strategies are being developed to reduce the loading of critical pollutants to Lake Michigan and integrate environmental protection and natural resource management efforts.

Lake Superior

Lake Superior is a unique and vast resource of fresh water covering 31,700 square miles. It is the largest freshwater lake in the world by surface area and can hold the water from all the other Great Lakes along with three more Lake Eries. Lake Superior has not experienced the same levels of development, urbanization and pollution as the other Great Lakes. Although Lake Superior is the cleanest and most healthy of all the Great Lakes, it is still threatened by toxic pollutants that bioaccumulate in the food chain and persist in the environment. These substances can be transported long distances in the atmosphere and end up in the lake. Local sources contribute pollutants to air and water, adding to the pollutant load entering Lake Superior. Toxic pollutants are generated in the production of energy and the handling of

wastes and they are found in the products we use. Because of its long retention time (191 years), pollutants entering Lake Superior can remain in the lake for over a century before draining to the lower Great Lakes. Through the RAP and LaMP processes, the problems associated with toxic pollutants, as well as other environmental problems, are being addressed.

Lakewide Management Plans

In the past year, through the interagency cooperation and commitment of the LaMP workgroups, the initial planning work for the Lakewide Management Plans for both Lakes Michigan and Superior was completed. This agreement among the agencies, to accelerate the planning phase and develop implementation strategies around existing data or information, will lead to faster implementation of projects designed to restore or protect the beneficial uses of the Great Lakes basin ecosystems. In Wisconsin, there are some specific areas for which projects are proposed:

- Removal of dams—This effort is aimed at restoring free-flowing streams and providing additional habitat for anadromous fishes. Coupled with these removal projects, there is a need for assessments and remedial strategies to deal with the contaminated sediments, which may have accumulated above the dams. These strategies need to be established in the context of wholelake Total Maximum Daily Loads (TMDLs) strategies to reduce critical pollutants to levels that will protect standards.
- Riparian habitat restoration—These efforts are aimed at improving the habitat in tributary streams for spawning and nursery areas. Additionally, protection and restoration efforts could be designed as buffer strips in order to reduce the nonpoint runoff pollution sources of critical pollutants. Protection of these riparian areas, in addition to wetland restoration projects, will provide relief from flooding and scouring effects of peak flows, and to some extent, also enhance the base flow characteristics of tributary streams.
- Pollutant prevention and reduction— These efforts will reduce critical pollutants to levels identified in the TMDL analyses. Sediment remediation, reduction of atmospheric loadings and nonpoint source controls are needed to eliminate the need for fish consumption advisories in the future.
- Management of exotic species— Effective strategies for preventing, and where possible, controlling populations of exotic species from becoming more established in the Great Lakes, are critical needs. These issues are regional to international in scope and must be dealt with at a national level to ensure that consistent across the board measures are employed for the management of exotic species.

Now that these areas have been identified, regional solutions are needed and regional coordination of individual agency action programs is an important function for U.S. EPA. On a two-year basis, either through the State of the Great Lakes Ecosystem Conference (SOLEC) process or the International Joint Commission (IJC) biennial meeting, the governments should be providing reports on the status of LaMP implementation.

Great Lakes Projects

Wisconsin is involved in many Great Lakes projects and programs that demonstrate the state's commitment to these natural treasures. Included in these efforts are the coastal nonpoint program, the Binational Program to Restore and Protect Lake Superior, lakewide management plans for Lakes Michigan and Superior, and the development of remedial action plans (RAPs) for the state's five areas of concern at Duluth/Superior, Marinette, WI/Menominee, MI, Green Bay, Sheboygan and Milwaukee.

Coastal Nonpoint Source Activities

As a coastal state, Wisconsin is required to develop and implement a nonpoint source management program under the provisions of Section 6217 of the 1990 Coastal Zone Act Reauthorization Amendments. The program requires "enforceable policies" to regulate compliance with U.S. EPA for six categories of nonpoint source activities including agricultural, urban, forestry, wetlands, hydromodifications and marinas. The specific management measures involve programs administered by the Departments of Natural Resources; Administration; Agriculture, Trade and Consumer Protection; and Commerce and Transportation. The management area under section 6217 includes virtually all of the Great Lakes drainage area in Wisconsin except the portion of the Wolf and Upper Fox Basins upstream of the outlet of Lake Winnebago.

Wisconsin has targeted many nonpoint source activities in this management area, including over 22 priority watershed projects. Nearly all of the urban areas will come under U.S. EPA's recently promulgated Storm Water Phase 2 regulations. Forestry activities are managed through use of best management practices contained in the WDNR published manual. Wetland protection and regulation of hydromodifications are statewide programs.

In 1999, Wisconsin agencies submitted information needed to meet program approval conditions identified by the National Oceanic and Atmospheric Administration and U.S. EPA.

The Lake Superior Binational Program

Because of its uniqueness, the International Joint Commission recommended in 1990 that Lake Superior be designated as a demonstration area where discharges and emissions of toxic substances that are long-lived in the environment and build up in the bodies of humans and wildlife, would not be permitted. In response, the governments of Canada and the United States (together with Wisconsin, Minnesota, Michigan and Ontario), entered into an agreement to create the "Binational Program to Restore and Protect the Lake Superior Basin." Wisconsin has taken a leadership role in protection and restoration of Lake Superior through the Binational Program.

Zero Discharge Demonstration Program

The Binational Program includes a zero discharge demonstration program for nine toxic chemicals, plus broader initiatives such as habitat protection. Since 1991 when the program was initiated, government agencies and citizens around Lake Superior have worked to set goals and objectives for the Lake Superior basin ecosystem. Many organizations have begun innovative projects to reduce toxic pollutants and to restore habitat.

The zero discharge demonstration program targets nine pollutants that are particularly toxic, accumulate in the food chain, and persist in the environment. They are:

Mercury	Dieldrin	2,3,7,8-TCDD (dioxin)
PCBs	Toxaphene	DDT and metabolites
Chlordane	Hexachlorobenzene	Octachlorostyrene

Some of these pollutants are responsible for fish consumption advisories in Lake Superior. The goal is to prevent these chemicals from entering the environment. The most effective way to do this is to focus on prevention rather than pollution control at the end of the pipe or stack. If these chemicals and their precursors are not used in processes or products, they cannot be released into the environment. The idea is to eliminate causes of pollution rather than treating the symptoms (i.e., shift from control to prevention). Pollution prevention can lead to lower production costs, increased efficiencies and better protection of the environment.

Lake Superior is the cleanest and most healthy of all the great Lakes, but it is still threatened by toxic pollutants.

The zero discharge demonstration program challenges governments, industry, and society to find ways to eliminate releases of these chemicals. "Zero discharge" is a conceptual goal. It expresses the idea that we, as a society, do not want to put these pollutants into the Lake Superior environment.

For five years the Lake Superior Binational Program agencies and citizen groups worked together to develop reasonable, but challenging schedules, to reduce the nine target pollutants. In 1996-97, the recommended schedules went through broader public review. These schedules serve as goals for pollutant reductions within the Lake Superior basin.

- **Mercury –** Reduce mercury sources from human activity by 60% from 1990 to 2000 (achieved), reduce mercury by 80% by the year 2010 and eliminate mercury sources from human activity by the year 2020.
- **PCBs –** Destroy 60% of PCBs in Lake Superior basin between the years 1990-2005 and destroy all accessible PCBs in the Lake Superior basin by the year 2000.
- **Dieldrin, chlordane, DDT, Toxaphene (canceled use pesticides) –** By the year 2000, collect and destroy all of these pesticides from the Lake Superior basin. Use clean sweep programs and education.
- **Dioxin, hexachlorobenzene, octachlorostyrene –** Reduce releases from human activity by 80% between the years 1990 and 2005 and eliminate releases from human activity in the Lake Superior basin by the year 2020.

The goals establish direction and reinforce the importance of all actions to reduce these pollutants. The reduction schedules do not have the force of law. These schedules are planning targets for the Lake Superior basin. They are not schedules for particular facilities or pollution sources.

The Binational Program is working with many organizations and individuals to develop actions and strategies that will help meet these goals. The Wisconsin Lake Superior Advisory Team is a public stakeholders group that was formed by WDNR to advise the state on specific implementation strategies for Wisconsin.

The Binational Program Agreement of 1991 describes a three pronged approach consisting of voluntary pollution prevention, controls and regulations, and special designations for Lake Superior. Progress on all three fronts will require innovative actions and public support. Current laws and regulations will not result in achievement of the goals. It will require incentives and new programs. The Binational Program also recognizes that solutions must not cause social or economic disadvantages for residents of the Lake Superior basin and should support a sustainable economy.

Because long-range atmospheric transport is an important pathway for toxic substances to enter Lake Superior, actions outside of the basin will also be needed to restore and protect the lake. Federal and state programs to deal with toxic substances will be important for Lake Superior.

Other Issues of Concern to the Binational Program

Other pollutants are causing problems in Lake Superior, but are not included in the zero discharge demonstration program. Some are found in contaminated sediment in harbors and bays. Stormwater is an important source for some metals and other pollutants. However, toxic substances are not the only concern for Lake Superior. Exotic species, habitat preservation, cumulative effects from development, land use practices, and sustainable development are all issues of concern to the Binational Program. Some of the objectives of the program are summarized below.

- Lake Superior should sustain diverse healthy reproducing aquatic communities free from chemical contaminants from human activities.
- Introduction of new exotic or nuisance species should be prevented.
- The Lake Superior ecosystem should support a diverse, healthy, reproducing and self-regulating wildlife community closely representative of historical conditions.
- Wildlife should be free from chemical contaminants from human activities.
- Nearshore, shoreline and wetland aquatic habitats are crucially important for the Lake Superior ecosystem. Key sites should be identified, protected and restored. These key sites support reproduction and rearing of fish, water birds, mammals, other wildlife, and plants.
- Land use and water use decisions and planning should consider and protect against long-term and incremental landscape change, habitat destruction and fragmentation.
- Land use planning and regulation should minimize or avoid destruction impacts to Lake Superior tributaries.
- Fish and wildlife should be safe to eat; consumption should not be limited by contaminants from human activity.
- Water should be safe to drink and safe for total body contact activities.
- Human use of the Lake Superior basin natural resources should not deny current and future generations the benefits of a healthy, natural Lake Superior ecosystem.
- The Lake Superior ecosystem provides resources and services to humans that should be valued as environmental capital, in the same way that other capital is assigned value.

The above objectives will be implemented in specific strategies and actions in the Lakewide Management Plan (LaMP) for Lake Superior.

RAPs For Water Quality Attainment

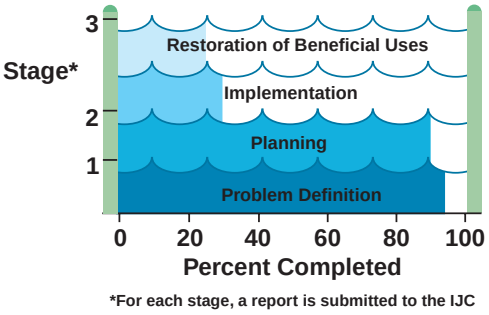
Figure 22. Location of RAP sites.

Wisconsin is responsible for implementing remedial action plans (RAPs) at five Great Lake sites, four on Lake Michigan and one on Lake Superior (Figure 22). At two of the RAP sites, it is a shared responsibility with adjoining states. For the Menominee RAP, Michigan and Wisconsin share responsibility for implementation, and for the St. Louis and Duluth/Superior Harbor RAP, the WDNR is assisting Minnesota, which has the primary responsibility.

All of the five RAP sites are in the process of implementing the recommendations contained in the Phase I planning documents. Actions are being implemented at each of the RAP sites that are aimed at restoring and protecting the designated uses in the Areas of Concern. What follows is a description of what activities are occurring and the progress that has been achieved over the last four years in meeting the goals and objectives established for Wisconsin's RAP sites.

Lower Green Bay and Fox River

Figure 23. RAP status



*For each stage, a report is submitted to the IJC

The Lower Green Bay and Fox River Area of Concern (AOC) consists of the lower 11.2 kilometers of the Fox River below the DePere Dam and a 55 square kilometer area of southern Green Bay out to Point au Sable and Long Tail Point. The drainage area encompasses portions of eighteen counties in Wisconsin and 40 watersheds of the Upper Fox River, Wolf River and the Lower Fox River Basins, including the largest inland lakes in Wisconsin, Lake Winnebago and its pool lakes. While water quality problems and public use restrictions are most severe in the AOC, water resources of the entire basin are affected by runoff pollution from rural and urban areas, municipal and industrial wastewater discharges and degraded habitats. Figure 23 shows the RAP status for the Stages 1, 2 and 3.

Beneficial Use Impairments

Eleven use impairments have been documented and two are suspected of being impaired for the Lower Green Bay and Fox River AOC through the Remedial Action Plan (RAP) process (see Table 14). Ecosystem services and human uses such as fishing, boating, swimming, hunting and passive recreation have been impaired. Soil erosion and runoff pollution cause most use impairments from upstream tributaries, persistent bioaccumulative contaminants in river and bay sediments, and habitat losses. Turbid, algae-laden waters degrade aquatic habitats and restrict swimming. Consumption advisories warn against eating mallard ducks and twelve species of fish. Shipping and navigation are impaired by sediment loading from soil erosion and the high cost of dredging and disposing contaminated sediments.

Table 14. Beneficial Use Impairments

- Restrictions on fish and wildlife consumption.
- (s) Tainting of fish and wildlife flavor.
- Degradation of fish and wildlife populations.
- (s) Fish tumors or other deformities.
- Bird or animal deformities or reproductive problems.
- Degradation of benthos.
- Restrictions on dredging activities.
- Eutrophication or undesirable algae.
- Restrictions on drinking water consumption, or taste and odor.
- Beach closings.
- Degradation of aesthetics.
- Degradation of phytoplankton and zooplankton populations.
- Added cost to agriculture and industry.
- Loss of fish and wildlife habitat.

RAP Status

The Lower Green RAP was developed by the WDNR using a multi-stakeholder partnership with other agencies, local governments, scientists, citizens, industries and environmental groups. More than 75 people participated for two years on four technical advisory committees and a citizen's advisory committee for development of this community-based plan. The technical advisory committees have developed reports identifying the problems, goals and objectives for management, and technical solutions to restore the bay and river. The citizen's advisory committee defined a "desired future state" for Lower Green Bay as part of Wisconsin's Water Quality Management Plan in 1988. For over ten years, plan implementation was facilitated by WDNR and local stakeholders through a Green Bay RAP Public Advisory Committee (PAC), Science and Technical Advisory Committee (STAC) and Public Education and Participation Advisory Committee (PEP). In 1999, the PAC and PEP Committees were disbanded and a Lower Fox River Partnership Group and a Fox-Wolf Basin Advisory Council were formed to promote ecosystem-based management in the Fox-Wolf Basin.

The Green Bay RAP Science and Technical Advisory Committee remain active, advising these and other groups. Additional nonprofit organizations have been established by community leaders to promote implementation of nonpoint source pollution controls (Great Lakes Nonpoint Abatement Coalition) and to determine the most cost-effective actions to meet the nutrient and suspended solids objectives of the RAP (Fox-Wolf Basin 2000).

Substantial progress has been made in developing the RAP and implementing recommended actions. Nearly one-third of the plan's 120 recommended actions has been implemented and another one-third initiated. However, despite incremental improvements to prevent water pollution, restore habitats, improve public access and further define the causes of impaired uses, none of the problems in the AOC have been completely solved. Recommendations are being implemented sequentially with the easiest ones having been completed and the more difficult and costly actions yet to be implemented. Full RAP implementation will extend well beyond the year 2000.

RAP Milestones & Priorities

Stages I and II of the RAP were completed in 1987 and adopted as part of Wisconsin's Water Quality Management Plan in 1988. The RAP was updated in 1993. Since 1993, thirty-eight of the 120 recommended remedial actions have been implemented. The following are remaining priority actions to be implemented:

- Nonpoint source abatement/pollution and prevention including comprehensive watershed projects to abate runoff pollution, TMDLs for phosphorus and suspended solids in the Fox-Wolf basin, and riparian buffers throughout the Fox-Wolf basin.
- PCB contaminated sediment remediation in 39 miles of the Lower Fox River
- Habitat protection and restoration that involve restoring an eroded chain of barrier islands and associated aquatic habitats (Cat Island archipelago), restoring littoral habitats, and protecting remaining wetlands
- Exotic species prevention
- Stewardship and sustainability which includes the sustainable Green Bay initiative
- Education and outreach
- Research and monitoring including the state of the bay report
- Enhance public access

Milwaukee Estuary

The Milwaukee Estuary Area of Concern (AOC) encompasses about 14,000 acres (22 square miles) and includes: the Milwaukee River downstream of 35th Street; the Kinnickinnic River downstream of Chase Avenue; the Inner and Outer Milwaukee Harbor; and the near shore areas of Lake Michigan from Sheridan Park to the south to the City of Milwaukee's Linnwood water filtration plant to the north. This may seem like a lot of area, but the reality is that the AOC is at the end of a basin draining more than 850 square miles (the AOC is only 2.5% of the entire drainage basin); cleaning up the AOC also means correcting upstream problems too.

The 1995 Remedial Action Plan emphasizes the basin approach to correcting problems in the AOC. The plan further defined problems and made 32 recommendations to help meet the goals defined by the RAP committees. To date, substantial progress has been made on 30 recommendations (93%). The following is a brief progress report on meeting the RAP recommendations and on the contaminated sediment management strategy, a cornerstone of the RAP effort.

Highlights

The external partnership team for the Milwaukee River Geographic Management Unit (GMU) is now operational. This diverse partnership team is the WDNR link to the public, businesses and organizations throughout the Milwaukee River Basin. Many of the representatives on the partnership team are knowledgeable of the RAP. The partnership team has included the objective to implement the Milwaukee RAP as one of their goals.

The Milwaukee River Basin Environmental Indicators Pilot Project is complete. The objective of the project was to develop a process to refine environmental indicators on a watershed basis. The WDNR solicited public input up front to determine priorities for this project. This unique approach gave the WDNR insight into the priorities of the general public regarding environmental issues and information needs. The report is accessible through the WDNR web site on the Milwaukee River Basin page at www:dnr.state.wi.us/org/gmu/milw.

RAP Recommendation Summary

The WDNR continues to conduct quarterly water quality monitoring for long-term analyses at Estabrook Park. The Milwaukee Metropolitan Sewerage District (MMSD) has also been a valuable partner through sharing data with the WDNR. The WDNR has been conducting baseline monitoring throughout the Milwaukee River Basin on streams where there is little or no information available.

Information on sediment toxicity conducted on Lincoln Creek (above) will be used to develop recommended actions for cleaning up the contaminated sediments.

Phytoplankton and zooplankton have been collected and MMSD has been analyzing the samples to determine the extent of the use impairment. At Estabrook Park and selected sites throughout the basin, the WDNR is continuing to collect and analyze macroinvertebrate information. The Lake Michigan Fisheries Work Unit is in the process of completing their Milwaukee River Comprehensive Fisheries Survey, which will provide a wealth of information about the fish community in the lower portion of the river. The WDNR is also collecting fisheries data through the baseline-monitoring program.

Toxicology assessments for fish health have been completed in the Little Menomonee River, Lincoln Creek and in Ruck Pond on Cedar Creek. Migratory fish like trout and salmon are sampled on a regular basis (annually or biennially) for fish tissue contamination in the Milwaukee River Basin. Native fish are sampled approximately every 5 years. The WDNR will be establishing index sites to sample native fish species biennially for trend analyses.

The WDNR has been monitoring the movement of PCBs through the Milwaukee River and Cedar Creek Mass Balance Studies. The information is being used to develop recommendations for cleaning up the contaminated sediments. The University of Wisconsin-Milwaukee, under contract with the WDNR, has completed a sediment GIS project for the AOC and some upstream portions. A project to identify the soft sediment deposits for rivers in the AOC is mostly completed as well as the portion of the Milwaukee River upstream of the AOC to the confluence with Cedar Creek. Bulk chemical and physical analysis of sediment deposits and traps is ongoing in the AOC as time and funding allow. Sediment toxicity testing is being conducted at a number of sites with much of the work already completed on Lincoln and Cedar Creeks.

Demonstration Projects

There are a number of projects in the AOC that are underway:

- The Milwaukee Metropolitan Sewerage District has contracted with facilities in the northern and southern portions of their service area to establish a permanent household hazardous waste collection facility.
- The WDNR is making progress in controlling runoff from bulk storage piles at industrial sites through the stormwater-permitting program.
- The WDNR is working with landowners, Friend of the Menomonee River and the Milwaukee River Revitalization Council to create vegetative buffer zones on tributary streams.

- Streambank restoration and stabilization is an ongoing activity that involves a cooperative effort among Milwaukee County Parks, WDNR and municipalities.
- Several riverway public access trails are being developed including the Milwaukee River Walk, Hank Aaron State Trail and Ice Age Trail.
- Work is underway to restore the Milwaukee River per the North Avenue Dam Feasibility Study. This effort is one of the largest ecosystem restoration projects in the state. The WDNR is currently fine tuning the aquatic habitat component of this project.

Information and Education

The RAP Information and Education Committee was instrumental in facilitating the development of an interpretive kiosk at Kilbourn Avenue bridge in cooperation with the Milwaukee County Zoological Society, the Milwaukee River Revitalization Council and Donnelly design. Excellent information and education work on nonpoint source pollution is being conducted by the University of Wisconsin Extension, and by the City of Milwaukee stormwater program. A program called Testing the Waters is going well in the basin. About 40 schools are now participating in this program throughout the basin. Thousands of middle and high school students are involved in monitoring area rivers, and reporting their findings at annual Student Congress. Water Action volunteers (a joint effort of WDNR and UW-Extension) are really expanding with many groups and private citizens participating in this program in the basin.

Contaminated Sediment Management Strategy

This strategy is the cornerstone of the Milwaukee RAP. Contaminated sediments affect every ecosystem component. The RAP committee designed a strategy to effectively manage the sediments throughout the Milwaukee River Basin that includes the following:

- Progress has been made on over 50% of the items outlined in the strategy.
- The WDNR has completed the sediment GIS system, and will be building more information into this project and expanding it to include water quality and stormwater monitoring data in the future.
- The WDNR has completed the mass balance studies for Cedar Creek and the Milwaukee River for PCBs. The information gained from these projects is being used to address the problem of contaminated sediments.
- Over 700 kilograms of PCBs were removed from Ruck Pond in Cedarburg. This is the most upstream PCB contaminated site on Cedar Creek. The WDNR is working with the responsible parties to address the remaining contaminated sediments.
- The Army Corps of Engineers is working on a project to find innovative ways to prolong the Confined Disposal Facility (CDF). This will prevent the addition of another cell in the harbor. The sediment reuse initiatives being tested should prolong the life of the CDF for another 20 years. In addition, the frequency of dredging has slowly decreased. Instead of having to dredge every other year, they can now wait from 2 to 4 years between dredging project in some areas.

Sheboygan River and Harbor

The Sheboygan River Area of Concern includes the Sheboygan Harbor and 14 miles of the river up to the Sheboygan Falls Dam. The Sheboygan River, a tributary to Lake Michigan, was designated as a Superfund Site by U.S. EPA in 1985 because of PCB contaminated sediments. Tecumseh Products Company, Thomas Industries and Kohler Company have been identified as potentially responsible parties.

The Sheboygan River Superfund project is at a pivotal juncture. A Record of Decision is expected from U.S. EPA in 2000. The implementation phase of this project will usher in the long-awaited sediment remediation of the Sheboygan River. WDNR staff is working with fellow trustees from U.S. Fish and Wildlife and National Oceanic and Atmospheric Administration (NOAA) to determine the Natural Resources Damage Assessment for the restoration phase of

the Sheboygan River Superfund Site. For a more detailed description of the cleanup efforts, refer to the "Contaminated Sediment Management Section."

WDNR is working on removing the Franklin Dam on the Sheboygan River. An environmental assessment was completed and a public meeting was held. The impoundment has been drawn down and seeded to stabilize the sediments over the winter. Franklin Fire Department, the dam owner, has notified adjacent landowners that they intend to deed the flowed lands to each landowner at the conclusion of the restoration work. The dam required either extensive repair or removal, and the owner did not have the funds needed to repair the dam.

There is a strong volunteer monitoring base in the Sheboygan area. The Ellwood H. May Environmental Center of Maywood is working with the WDNR and UW-Extension to establish a pilot web site to manage volunteer water quality monitoring efforts. WDNR is also conducting stream assessments in and around the Area of Concern as part of the baseline monitoring efforts.

Lower Menominee River

The Menominee River is a boundary water between Wisconsin and the Upper Peninsula of Michigan that drains to Green Bay. The Menominee River Area of Concern includes the lower three miles of the river from the upper Scott Paper Company dam to the river mouth and approximately three miles north and south of the adjacent shoreline of Green Bay. The Area of Concern includes portions of Marinette County in Wisconsin and Menominee County in Michigan.

The Lower Menominee River RAP, updated in 1996 by the WDNR, the Michigan Department of Environmental Quality and a citizen's advisory committee, addressed water quality concerns in the Area of Concern. Implementation of this long range planning strategy continues. Some of the conditions contributing to the ecological impairments have been remediated and other actions are either ongoing or part of a long- term remediation strategy.

A paint sludge contamination site on the shoreline of Green Bay in Menominee, Michigan, was cleaned up and wastewater treatment systems in Marinette (bypassing) and Menominee (combined sewer overflows) have been completed. An ecologically important shoreline in Marinette was designated and is protected as a Natural Area and a bulkhead line designation on the river shoreline in Marinette was removed. A coal tar contamination site has been included on the WDNR coal tar cleanup list.

Sediment Cleanup Efforts

Remediation of arsenic contamination at one of the primary contamination sites in the Area of Concern was started in 1999 and is scheduled to continue in the larger ship turning basin as part of an U.S. EPA Resource Conservation and Recovery Act (RCRA) consent order. The U.S. EPA has issued an Administrative Order of Consent requiring remediation of arsenic contamination in the Lower Menominee River Area of Concern. Ansul was required and has met the condition to remove all soft sediments from the Eighth Street Slip behind the cofferdam by the end of 1999. For a more detailed discussion of the cleanup efforts, refer to the "Contaminated Sediment Management Section."

The consent order, designed to ensure the protection of human health and the environment, contains the following interim enforcement measures, which have been completed:

- Installation of a barrier to prevent migration of arsenic from the site.
- Removal of arsenic contaminated sediments from the Eighth Street Slip.
- Implementation of interim measures to address contaminated sediments in the turning basin.

Arsenic contamination of soil, sediment, groundwater, surface water and exposed biota was identified as a primary ecological problem within the Area of Concern. The source of arsenic was a former herbicide manufacturing facility at the site, which was identified as the

greatest single source of arsenic to Lake Michigan. Ansul produced arsenic-based herbicides from 1957 to 1977. Processed wastes, including arsenic salts, were stored next to the river, and some of the wastes were discharged directly into the river. At one time an estimated 95,000 tons of waste salt were stored on site.

St. Louis River and Duluth-Superior Harbor

The St. Louis River and Duluth-Superior Harbor area of concern includes 39 miles of the St. Louis River below Cloquet, Minnesota, the river estuary, Duluth-Superior Harbor and the lower Nemadji River. The area of concern straddles the Minnesota-Wisconsin border. Minnesota has the lead for RAP coordination.

The RAP began in 1989 as a collaborative effort between the Minnesota Pollution Control Agency and the WDNR. At that time, the agencies created a Citizens Advisory Committee (CAC). In 1997, the CAC changed to an independent nonprofit organization known as the Citizens Action Committee. Many of the original citizen and agency partners are still active in the RAP and CAC.

Stage 1 of the RAP identified nine of 14 beneficial uses as being impaired. Some impairments were associated with the physical loss and degradation of habitat, and with the lost of an estimated 7,700 of 12,000 acres of wetland and open water habitat in the estuary since settlement. Other problems were related more to pollution and toxicity. For years, the river smelled bad from industrial discharges. That changed in 1978, when the Western Lake Superior Sanitary District wastewater treatment plant began operation. Nevertheless, pollution continues to come from sources such as contaminated sediments, abandoned hazardous waste sites, poorly designed or leaky landfills, airborne deposition, industrial discharges, chemical spills, improperly sewered wastes and surface runoff.

RAP Status and Milestones

The RAP process identified 43 recommendations in 1995. Implementation began immediately and continues today. Some recommended actions are well underway, including:

- Land acquisition, with 34,000 acres bordering the river permanently protected by purchase or donation,
- Connection of Fond du Lac, Minnesota, which has a high percentage of failing septic systems, to the Western Lake Superior Sanitary District,
- Programs to reduce sewerage bypasses by keeping stormwater out of sanitary sewer systems, and
- Development of a habitat plan for the lower St. Louis River.

Stage 1 of the RAP, published in 1992, identified the problems in the Area of Concern. Subsequently in April 1995, a progress report was published containing 43 recommendations. In 1997, the Citizens Advisory Committee became the nonprofit Citizens Action Committee.

RAP Priorities

Contaminated sediments are an important priority in the AOC. Studies conducted by state and federal agencies in the late 1990s have provided a good understanding of the type, severity and location of contaminated sediments. These studies include work done at two Superfund sites on the Minnesota side. Some upland clean-up efforts have occurred. Remediation of contaminated sediments is expected to be underway at sites on both sides of the state line by 2005.

Mercury is a contaminant of particular concern in the St. Louis River. A new project, the St. Louis River Watershed TMDL Partnership, will develop a total maximum daily load (TMDL) for mercury. The TMDL process is designed to improve impaired waters like the St. Louis River, where all facilities with discharge permits are operating within their permitted limits, but have pollutant levels exceeding state standards. This process will complement the mercury-reduction efforts that are already ongoing in the watershed.

Habitat restoration and protection are also important priorities. Even though the estuary has suffered extensively from habitat loss and degradation, it also retains tremendous habitat value. Because habitat issues are such a high priority, a comprehensive habitat plan is being developed to enhance the biological diversity and ecological integrity of the lower St. Louis River. The project will provide an estuary-wide vision for resource management and conservation. It will also provide a consensus list of conservation and management objectives, targets and actions along with a project that is ready to submit for funding.

Public involvement and outreach have always been important components of this RAP. A host of partners are working together to improve the St. Louis River. These include the U.S. EPA, Minnesota Pollution Control Agency, Minnesota DNR, WDNR, local and tribal governments, Minnesota and Wisconsin universities and Sea Grant Programs, the St. Louis River Citizens Action Committee, River Watch Project, River Quest, Harbor Technical Advisory Committee, U.S. Army Corps of Engineers and numerous private businesses and individuals.

Invasive Species

State and Interstate Aquatic Nuisance Species Plans

Invasive species have long been recognized as a serious problem in Wisconsin that not only threatens the Great Lakes, but also inland waters. Wisconsin has developed a Comprehensive State Management Plan (still in draft form) to deal with this issue. The plan, developed in response to the National Invasive Species Act of 1996, provides the framework for a comprehensive state program to address the problems caused by invasive aquatic nuisance species. The scope of the activities are broad and aimed at preventing new introductions, controlling the spread of existing populations, and implementing abatement strategies to safeguard public health and the environment. The state will be submitting this plan to the national Aquatic Nuisance Species Task Force for their approval later in 2000. Approval of Wisconsin's plan by the Task Force would provide funding for the state's ANS program.

The Eurasian ruffe is a recent invader to Lake Superior, being first reported in 1986.

The National ANS Task approved an interstate ANS plan on the St. Croix National Scenic Riverway in 1998. The plan was prepared jointly by Minnesota, Wisconsin and the tribes. It has provided federal funding to each state for $20,000 and to the tribes for $2,500 in FY99 and FY00. The federal dollars have been used to protect the St. Croix River against the introduction of zebra mussels. Specific actions have been aimed at enforcing state ANS laws on the St. Croix, monitoring for zebra mussels via dive searches and veliger plankton tows, and information/education efforts such as posting signs and providing information to boaters at the water access sites. A state law that was enacted in 1996 prohibits the placement of any boat, trailer or equipment in the Lower St. Croix if there is reason to believe that zebra mussels are attached. The regulations address the risk to several endangered natural mussel species in the St. Croix River if zebra mussels colonize upstream of the Mississippi River.

State Policy on Invasive Species

The WDNR has developed a draft policy on the unintentional introduction of aquatic and terrestrial invasive species. The policy needs to be approved by the Natural Resources Board before it becomes official WDNR policy. The purpose of the policy is to minimize the impacts of invasive species to the natural resources of the state. To implement the policy, the WDNR will need to establish procedures and strategies for handling unintentional introductions of invasive species determined to be ecologically harmful. The policy, as drafted, compliments the state and interstate plans and provides a more consistent approach to managing prob-

lems posed by both aquatic and terrestrial invasive species. The objective of the policy and the state management plan is to substantially reduce the risk of new introductions of invasive aquatic species and develop control strategies, when warranted, to avoid or minimize the impact to natural ecosystems as well as economic impacts.

Invasive Species of Concern

Purple loosestrife is a wetland plant from Europe and Asia that has expanded its range to much of North America.

Numerous aquatic nuisance species have been introduced into the Great Lakes and dispersed into the inland waters of Wisconsin by various pathways. Of particular concern has been the introduction of invasive species via ballast water. Two other potential sources of introduction of ANS, the bait harvest industry and aquaculture industry, have not been as well documented. Over 100 species of fish, plants, invertebrates, algae, and pathogens have been introduced to the Great Lakes since the early 1800s resulting in the transformation of Wisconsin's aquatic ecosystems.

A number of invasive species are currently in Lakes Michigan and/or Superior – the spiny water flea, round goby, ruffe, white perch, *Cercopagis pengoi* (a crustacean), and *Daphnia lumholtzi* (a zooplankton species) – and could invade the inland waters of Wisconsin at any time. Other invasive species have already invaded Wisconsin's inland waters and have caused a variety of ecological problems. Examples of these species include: the rusty crayfish, purple loosestrife, Eurasian watermilfoil and zebra mussels. Of these invasive aquatic species, Eurasian watermilfoil and zebra mussels are most problematic to Wisconsin's inland waters.

Eurasian Watermilfoil

Eurasian watermilfoil first showed up in Wisconsin's counties in the 1960's. In the past three decades, this exotic species has significantly expanded its range to about 310 lakes in 54 of Wisconsin's 72 counties. Figures 24 and 25 show how the range of Eurasian watermilfoil has expanded in Wisconsin over the last five years from 1994 to 1999. Because of its potential for explosive growth and its incredible ability to regenerate, Eurasian watermilfoil can successfully outcompete most native aquatic plants, especially in disturbed areas. In a number of Wisconsin lakes, Eurasian watermilfoil has formed huge monoculture stands with vast mats of surface foliage that shade-out native aquatic plants and diminish the aesthetic beauty. Recreational activities like swimming, boating and sport fishing are also diminished on Wisconsin lakes infested with Eurasian watermilfoil. A variety of techniques have emerged for controlling Eurasian watermilfoil populations on Wisconsin's lakes. These techniques include mechanical cutting and harvesting in open areas, limited use of herbicide treatments and more recently the introduction of weevils as a biological control agent. A 1992 WDNR report to the Wisconsin Legislature on Eurasian watermilfoil provides more details on how Wisconsin has, and will continue to deal with this aquatic nuisance species.

Zebra mussels

Zebra mussels pose a significant threat to native clams.

Zebra mussels are a more recent invader than Eurasian watermilfoil, having arrived in the Wisconsin waters of Lake Michigan in 1991. Since that time, zebra mussel populations have expanded their range in Wisconsin to include: the nearshore areas of Lake Michigan from Racine to Washington Island, Green Bay, Superior Harbor, the Mississippi River, 16 inland lakes, the Lower Fox River, a portion of the Bark River in southeastern Wisconsin, and a number of rivers that are tributary to Lake Michigan. Figures 26 and 27 show how zebra mussels have expanded their range in Wisconsin over the last five years from 1994 to 1999. Zebra mussel populations are highest in Green Bay where densities

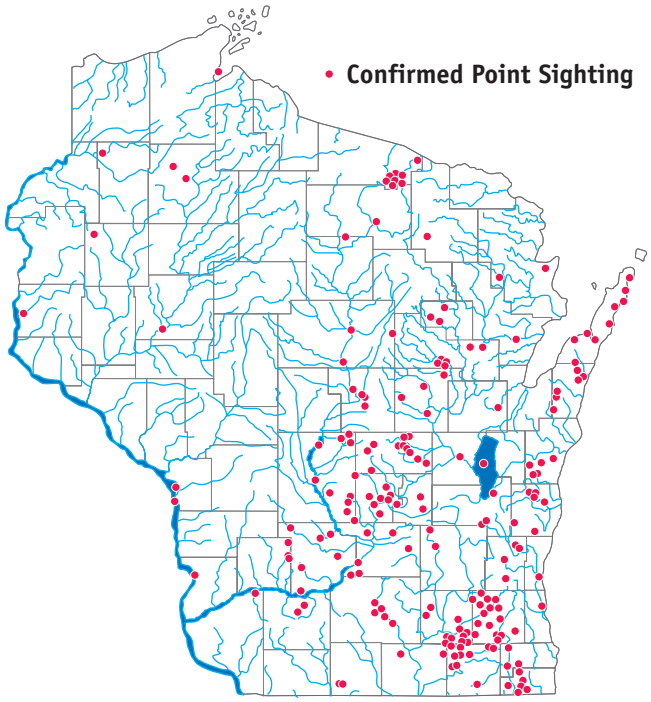


Figure 24. The range of Eurasian Water Milfoil in Wisconsin as of November 1994. (200 inland lakes infested)

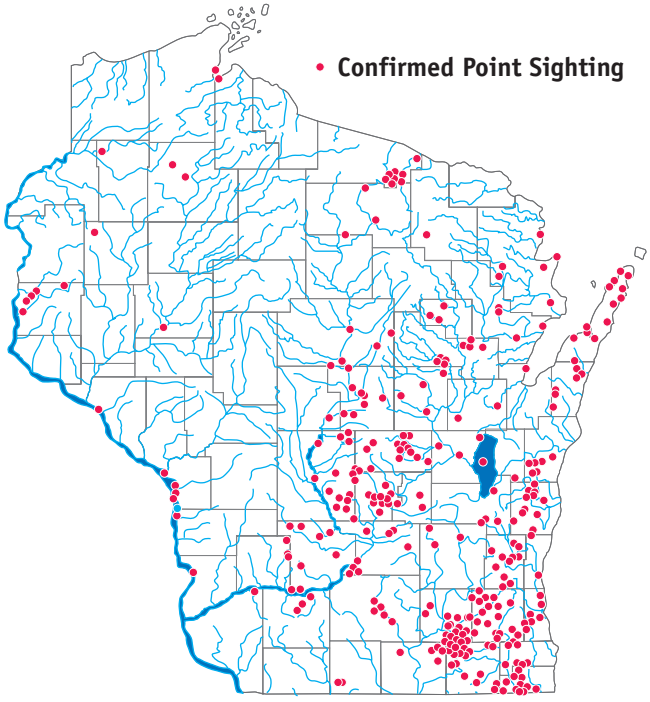


Figure 25.The range of Eurasian Water Milfoil in Wisconsin as of Fall 1999. (319 inland lakes infested)

are approaching levels found in Lake Erie. Resource managers are particularly concerned about the potential impacts to the food chain, native clams and fisheries in Wisconsin's waters.

Another area of concern is the Mississippi River where the population of zebra mussels is steadily increasing to over several thousand per square meter in some portions of the river. Unusually low dissolved oxygen concentrations in the range of 3-4 mg/L were observed in portions of the Mississippi River during the early summer periods of 1997 and 1998. High concentrations of zebra mussels were likely contributing to the low dissolved oxygen levels. Water clarity improved dramatically in some part of the Mississippi River in the late summer of 1997 which was likely influenced by the filter feeding activity of zebra mussels. These results are consistent with findings in other riverine systems where zebra mussels are present.

Zebra mussels are also negatively impacting native mussel populations in the Mississippi River. Native mussels are being smothered by high concentrations of mussels that attach themselves to their shells. A recent survey by the Corps in the East Channel of the Mississippi River at Prairie du Chien has revealed a substantial reduction in the diversity and density of native mussels. The decline was likely the result of zebra mussels whose densities reached over 10,000 per square meter in 1998. The East Channel was one of the best mussel beds in the Upper Mississippi River. Future efforts are being considered to relocate native mussel beds to other waters that are less likely to be impacted by zebra mussels.

Financial impacts have been significant to Wisconsin's water utilities (about $4 million based on 1993 figures) and to power plants (approximately $1 million in 1993). Although some costs have also been incurred by the lock and dam operators on the Mississippi River, these costs have been substantially less than for the raw water users. The environmental costs of the zebra mussel invasion to water resources are more difficult to quantify, and in most cases, are unknown. The long-term costs, however, are likely to be significant. Ecologi-

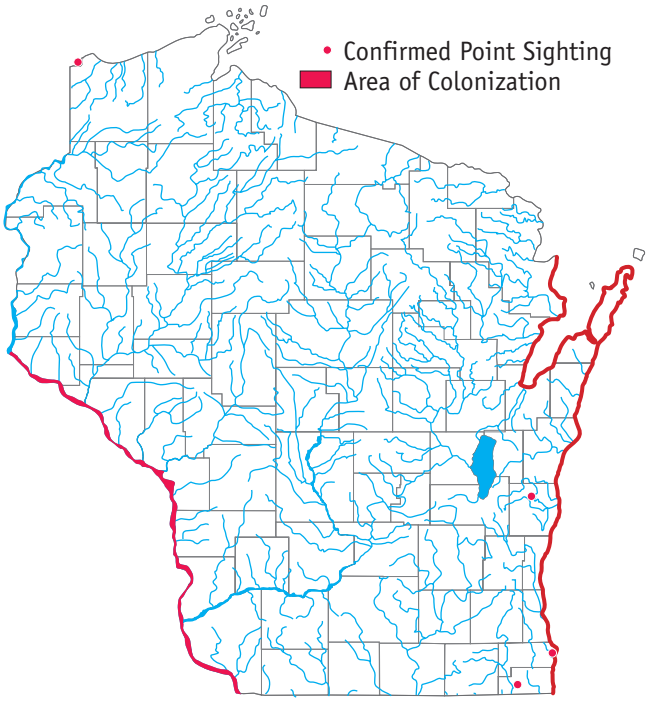


Figure 26. The range of Zebra Mussel in Wisconsin as of December 1994. (3 inland lakes infested)

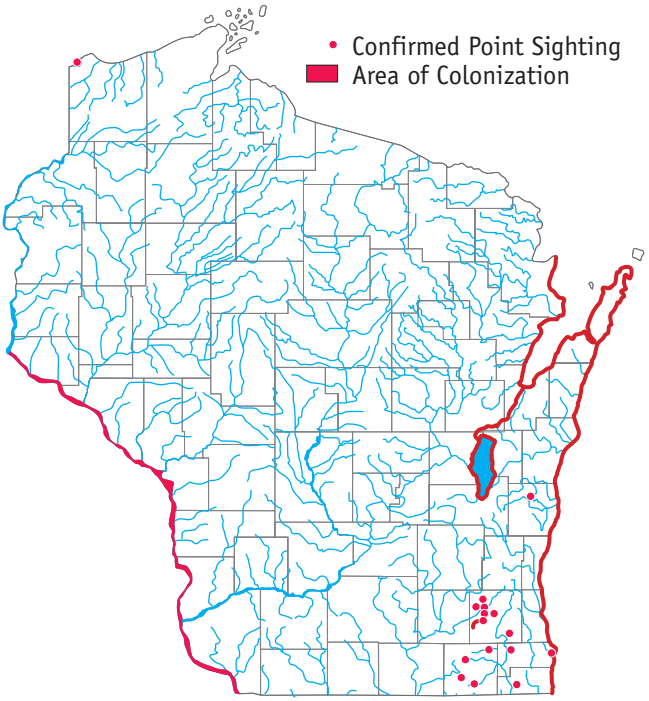


Figure 27. The range of Zebra Mussel in Wisconsin as of December 1999. (16 inland lakes infested)

cal studies have recently been completed on two inland Wisconsin lakes where zebra mussels first invaded in 1994. The results of these studies should provide more information on the ecological impacts.

A 1994 report to the Wisconsin Legislature provides more details on the efforts of WDNR and UW-Sea Grant to address the zebra mussel problem in the state.

Information and Education Efforts

Education is the key to controlling Eurasian watermilfoil, zebra mussels and other aquatic nuisance species. Education efforts by WDNR and UW-Sea Grant have focused on increasing public awareness about the problems posed by invasive aquatic species and the precautions that should be taken to avoid spreading ANS. The WDNR has repeatedly emphasized that cleaning boats can make a difference in slowing the spread of invasive species. New state funding of $25,000 annually has been allocated in the 1999-01 biennium specifically for information and education efforts. The funding is being targeted for the following activities:

- Signage at more boat launching sites to increase boaters' awareness of the procedures to follow for proper boat hygiene;
- Displays on invasive aquatic nuisance species for use at state parks and other areas to increase public awareness of the problem;
- Dissemination, development and printing of brochures, pamphlets and watch cards on ANS; and
- Public service announcement to focus attention to the problem and solutions.

The theme that the WDNR has used over and over to convey the message to recreational boaters and anglers is: "Remember…Clean boats… Clean Waters!"

Wetlands

Wetlands are defined in the state statutes as "… an area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions." Wetlands are formed where the cycle of water interacts with soils and vegetation to form a unique community of plants and animals. Because of the variability of these factors, many different types of wetlands can be found in Wisconsin, ranging from bogs to marshes to swamps.

Due to its extensive glacial geology in presettlement times, nearly a third of Wisconsin's land area was wetlands. As settlers arrived, they drained wetlands primarily for agricultural uses. Later wetlands were often filled for development, roads and other urban infrastructure. Of the estimated 10 million acres of original wetlands in Wisconsin, only about 5.3 million acres remain.

Wetlands provide habitat for a unique community of plants and animals.

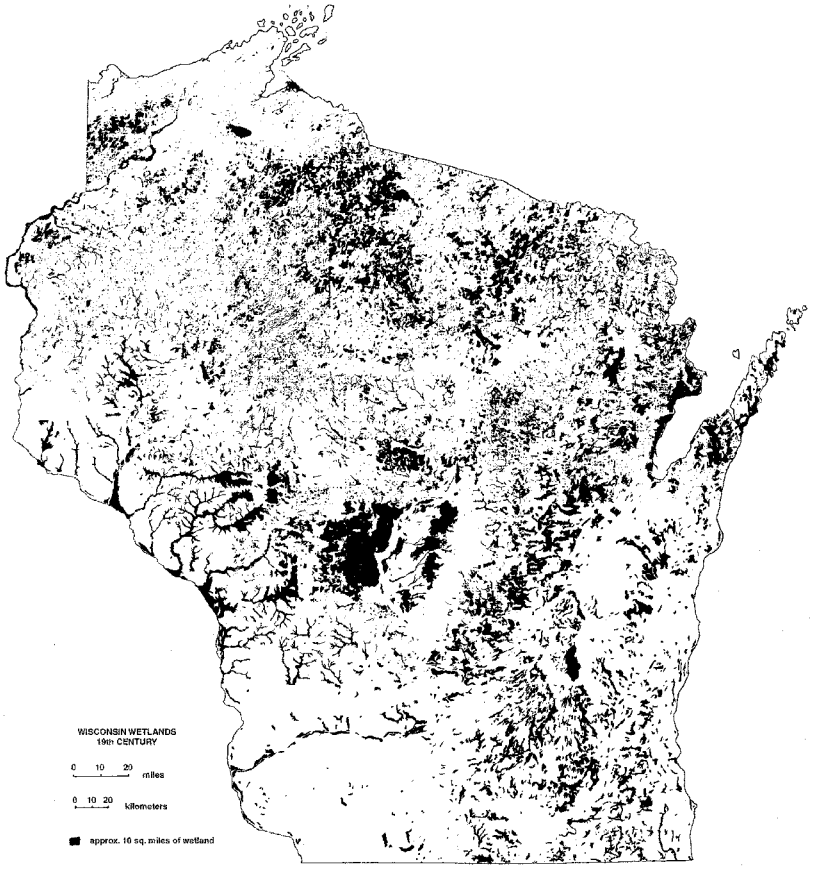
Types of Wetlands

The distribution of forested and non-forested wetlands at the time of settlement has been compiled from the notes of the original surveyors into a map showing the vegetation cover of Wisconsin in the mid-1800s (refer to Figure 28). Current land cover maps also show the distribution of forested and non-forested wetlands along with other general cover types (refer to Figure 29). Because of differences in the way these two maps were produced, they cannot be used to accurately predict statewide quantitative data of wetlands by type. However, these sources can provide useful data for landscape analysis.

The most refined representation of the current extent of Wisconsin wetlands is the Wisconsin Wetland Inventory, which was established to identify and classify the state's wetlands by plant community and hydrologic type. Wetlands of two acres or larger, or in some counties five acres, are outlined with point symbols showing smaller wetland occurrences. The inventory was completed in 1985 based upon 1978 map data, but is being revised and digitized as resources become available. The Digital Wisconsin Wetland Inventory is now available for all but seven counties. Updated maps, based on more recent aerial photography, are available for 25 counties. Fifteen counties are in the process of being updated and maps for 32 counties are based on 1978-79 aerial photography. Table 15 lists the extent of wetlands in each Wisconsin county (from the largest to the smallest wetland acreage) and mapping information.

It has been estimated that roughly 75 percent of Wisconsin's wetlands are privately owned, while the remaining 25 percent are in public ownership. Therefore, efforts to manage and protect wetlands must include a strong focus on providing education and technical assistance to private wetland owners.

Figue 28. 19th Century Wisconsin wetlands



Figue 29. Current extent of Wisconsin wetlands

Table 15. Wisconsin Wetland Inventory: Wetland Acreage By County

County	Year of any Update	Acres of Wetland	Total Surface Area (Acres)	% of County Mapped As Wetland	Wetlands as % of Satatewide Total	Min. Map Unit Size (Acres)
Price		252,992	801,721	31.6%	4.7%	5
Oneida		237,546	719,826	33.0%	4.4%	5
Marinette	1989	212,997	897,262	23.7%	4.0%	2
Douglas	1991	194,169	837,924	23.2%	3.6%	2
Marathon	1987	172,293	988,848	17.4%	3.2%	2
Ashland	1991	168,388	668,103	25.2%	3.1%	2
Sawyer		162,641	804,180	20.2%	3.0%	5
Forest		161,056	649,053	24.8%	3.0%	5
Oconto	1989	159,717	638,777	25.0%	3.0%	2
Iron	1991	151,065	484,660	31.2%	2.8%	2
Wood	1992	130,725	507,428	25.8%	2.4%	2
Shawano		127,778	571,244	22.4%	2.4%	5
Juneau	1988	122,485	491,325	24.9%	2.3%	2
Burnett		122,194	525,790	23.2%	2.3%	5
Lincoln		121,530	565,147	21.5%	2.3%	5
Taylor		120,979	623,973	19.4%	2.2%	5
Vilas		116,866	558,593	20.9%	2.2%	5
Jackson		113,070	631,862	17.9%	2.1%	2
Rusk		113,005	584,439	19.3%	2.1%	5
Waupaca	1993	112,761	480,729	23.5%	2.1%	5
Dodge		110,558	564,734	19.6%	2.1%	2
Langlade		108,800	558,558	19.5%	2.0%	5
Clark		100,338	778,048	12.9%	1.9%	5
Portage	1992	92,748	516,076	18.0%	1.7%	2
Bayfield	1991	80,252	944,902	8.5%	1.5%	2
Washburn		79,140	518,236	15.3%	1.5%	5
Chippewa		78,399	646,703	12.1%	1.5%	2
Columbia		75,404	495,274	15.2%	1.4%	5
Outagamie	1993	74,221	409,849	18.1%	1.4%	5
Fond du Lac		69,128	462,704	14.9%	1.3%	5
Marquette		68,881	291,541	23.6%	1.3%	5
Polk		60,921	587,088	10.4%	1.1%	5
Jefferson	1986	59,280	356,521	16.6%	1.1%	2
Green Lake		58,816	226,755	25.9%	1.1%	5
Waushara	1994	58,725	400,695	14.7%	1.1%	2
Monroe	1988	56,842	576,596	9.9%	1.1%	2
Waukesha		54,913	355,587	15.4%	1.0%	2
Adams	1988	52,268	414,589	12.6%	1.0%	2
Dane	1986	51,418	769,392	6.7%	1.0%	2
Door	1987	50,990	308,959	16.5%	0.9%	2
Florence		49,974	312,373	16.0%	0.9%	5
Manitowoc	1989	48,758	378,600	12.9%	0.9%	2

Table 15. Wisconsin Wetland Inventory: Wetland Acreage By County *continued*

County	Year of any Update	Acres of Wetland	Total Surface Area (Acres)	% of County Mapped As Wetland	Wetlands as % of Satatewide Total	Min. Map Unit Size (Acres)
Buffalo		44,934	438,092	10.3%	0.8%	5
Winnebago	1986	44,380	280,723	15.8%	0.8%	2
Dunn		44,222	545,329	8.1%	0.8%	5
Eau Claire		43,646	408,104	10.7%	0.8%	5
Trempealeau		43,386	469,855	9.2%	0.8%	5
Washington		42,652	275,743	15.5%	0.8%	2
Barron		42,640	552,248	7.7%	0.8%	2
Sheboygan	1987	40,447	328,739	12.3%	0.8%	2
La Crosse	1988	37,667	289,777	13.0%	0.7%	2
Menominee		33,545	229,117	14.6%	0.6%	5
Sauk		32,145	536,138	6.0%	0.6%	5
Walworth		28,746	355,458	8.1%	0.5%	2
Brown	1986	28,257	338,375	8.4%	0.5%	2
Kewaunee	1989	27,436	219,299	12.5%	0.5%	2
Crawford		27,331	366,561	7.5%	0.5%	5
Calumet	1994	24,736	204,714	12.1%	0.5%	5
Grant		22,869	734,656	3.1%	0.4%	5
Rock		19,424	461,148	4.2%	0.4%	2
Kenosha		17,012	174,605	9.7%	0.3%	2
Iowa		16,500	488,157	3.4%	0.3%	5
Ozaukee		16,265	148,456	11.0%	0.3%	2
Richland		15,210	375,209	4.1%	0.3%	5
Vernon		14,511	508,770	2.9%	0.3%	5
St. Croix		14,254	462,054	3.1%	0.3%	2
Racine		13,529	213,204	6.3%	0.3%	2
Green		12,301	373,790	3.3%	0.2%	2
Pierce		7,397	368,971	2.0%	0.1%	5
Pepin		7,235	148,683	4.9%	0.1%	5
Milwaukee		4,466	154,601	2.9%	0.1%	2
Lafayette		3,116	405,510	0.8%	0.1%	5
Total		5,385,290	34,760,750	15.5%		

1992 Estimate of Wetland Ownership*

Ownership type	Wetland Acres	Percent of Total
Wetlands in state ownership	515,718	9.7%
Wetlands in county ownership	458,687	8.6%
Wetlands in federal ownership	345,067	6.5%
Wetlands in private ownership	4,011,920	75.2%
Total	5,331,392	100%

*Based on Bureau of Forestry Reconnaissance Surveys

**Based on "Wetland Use in Wisconsin, Historical Perspectives & Present Picture" published in 1976.

Recent Wetland Losses

It is impossible to ascertain the true amount of recent wetland losses. It is not possible to track wetland acreage lost to legal drainage activities and to illegal or unreported filling. There are some indications that, at least in some areas of the state, unauthorized wetland filling is increasing. Because of gaps in the WDNR's ability to track all losses, estimates are likely to under-report the true amount of wetland loss. The Wetland Inventory is not updated frequently enough to document wetland losses or gains on a statewide basis.

Permitted Wetland Loss

WDNR has a system to accurately track some types of permitted losses authorized by federal permits under the Clean Water Act. This total is also a conservative estimate of the total permitted loss, because some activities pre-authorized by general and nationwide permits are not known. A review of Section 401 dealing with water quality certification shows that 2,884 acres of wetland fill were authorized between August 1991 and December 1999, after adoption of NR 103. This amounts to a rate of approximately 347 acres per year.

Recent Wetland Gains

It is also impossible to ascertain the true amount and rate of wetland gains in recent years. In urbanized areas of southeastern Wisconsin, some gains have occurred where farm abandonment has returned wetland conditions to previously drained land. The resulting wetlands, however, may be of lower quality. Because the current rate of updating the Wisconsin Wetland Inventory is slow at best, it is not possible to report these types of gains statewide.

Some significant gains have occurred through restoration. In recent years, a great deal of effort has been expended to restore and enhance wetlands through a variety of programs. Much of the activity is focused on waterfowl habitat acquisition, restoration and management through a partnership of state and federal agencies and private groups to meet the objectives of the North American Waterfowl Management Plan. Since 1991, approximately 51,525 acres of wetlands have been restored or acquired. Since acquisition is included in this total, it cannot be directly translated as wetland gain. However, it does indicate a very significant commitment of resources to wetland restoration.

Some gain in wetland acreage has occurred through restorations required as compensatory mitigation for permitted losses. The amount of acreage that has been restored through the Army Corps of Engineers has not been adequately documented. Field verification of completed projects is generally not done except for special cases.

One area of activity that is well documented is compensatory mitigation undertaken by the Wisconsin Department of Transportation. From 1990 to 1998, 1,904 acres of wetlands have been restored or created as compensation for permitted wetland loss.

Wetland Trends

Given the tools currently in use, a reliable determination cannot be made as to whether there has been a net gain or loss of wetlands in the 1990s. A comprehensive tracking system has not been devised that can account for all the sources of wetland loss and gain, or accurately sort out information from various sources and programs. Theoretically, the Wisconsin Wetland Inventory could be an authoritative measure of wetland trends if sufficient resources were devoted to updating the entire state on a more frequent basis. Any recent trends must be noted in the context of the approximately five million acres Wisconsin has lost since statehood.

Integrity of Wetlands

The quality of Wisconsin's remaining wetlands has been difficult to quantify. The biological integrity of some wetlands are being affected by agricultural drainage, runoff pollution, alterations of water flows in their watersheds, and loss of connections to quality upland habitat. As land use changes continue, the result can be loss of habitat quality, dominance by invasive species and poor water quality. Some wetlands are still relatively free of these disturbances.

Monitoring & Assessing Wetland Health

Currently, there is no systematic method for assigning use designations or assessing wetland health and function except for case studies under NR 103. Consequently, there is little information available to characterize the integrity of wetlands in Wisconsin on a statewide or even a regional scale. Although wetland inventory maps delineate the types and extent of wetlands in Wisconsin, there is no attempt to monitor wetland quality. This is recognized as a major gap in the wetland program.

The WDNR is developing a monitoring stategy to assess wetland health.

A statewide monitoring and assessment program has not been implemented because the tools do not exist. The WDNR is developing a monitoring strategy to better characterize wetland health and use support. The strategy focuses on developing scientifically based, yet practical assessment and monitoring tools. This is a daunting task that is being pursued at several levels. Funding through the federal wetland grant program is being used to develop monitoring tools via the following projects:

- **Development of a Wetland Biotic Index –** A preliminary index of biological integrity for palustrine depressional wetlands based on plants and macroinvertebrates has been developed. This project utilized 103 wetlands under varying degrees of disturbance, with 47 wetlands serving as least-disturbed reference wetlands. Research into additional metrics based on small mammals, herptiles, and zooplankton will be carried out over the next two years. In the long term, if the indexes produced by this research prove practical, this approach can be expanded to other wetland types. Wetland biological integrity indexes could be used in assessing overall wetland health, establishing biocriteria, designating impaired wetlands and monitoring trends. These indexes could be applied on a site by site basis by field staff or trained volunteers.
- **Development of a Floristic Quality Index for Wetland Plants –** A Floristic Quality Index for wetland plants will provide an assessment tool to evaluate wetland plant community health on a site by site basis. It would require a fairly high level of expertise in plant identification, but would be a fairly rapid method. This tool will be developed within the next two years.
- **Development of an "Invasive Species/Disturbance Index" –** While the previous two methods are site by site field methods, a method is needed to assess and characterize wetlands on a broader landscape scale. This could serve as a "filter" to determine which sites to target for closer assessment, but could also provide a rough characterization of wetland quality for targeting restoration work and for integrated planning purposes. Investigations and testing of methods for using remote sensing data to characterize dominance by invasive species and site disturbance will be carried out in the next two years.

Wetland Protection and Restoration Mechanisms

Wetland water quality standards contained in NR 103, Wisconsin Administrative Code, form the basis of Wisconsin's wetland protection and restoration program. Chapter 103, "Water Quality Standards for Wetlands," was adopted to participate effectively in the federal permit process administered by the US Army Corps of Engineers. State water quality certification is required for federal permits to be valid. Prior to adoption of NR 103, Wisconsin had no standards to apply to wetland alterations. NR 103 establishes narrative standards where uses are based upon wetland functional values. If NR 103 standards are not met, Wisconsin can deny water quality certification, giving the state an effective "veto" over Section 404 of the Clean Water Act for wetland fill permits. NR 103 standards are also applied when the WDNR makes other decisions that affect wetlands.

NR 103 standards are established to ensure the following wetland functions and values are maintained:

- Storm and flood water storage and retention and the moderation of water level fluctuation extremes.
- Water cycle functions including the maintenance of dry season stream flow, the discharge of groundwater to a wetland, the recharge of groundwater from a wetland to another area and the flow of groundwater through a wetland.
- Filtration or storage of sediments, nutrients or toxic substances that would otherwise harm the quality of other waters.
- Shoreline protection against erosion through the dissipation of wave energy and water velocity, and through the anchoring of sediments.
- Habitat for aquatic organisms in the food web.
- Habitat for residential and transient wildlife species for breeding, resting, escape cover, travels corridors and food.
- Recreational, cultural, educational, scientific, and natural aesthetic values and uses.

If an activity is proposed that will affect wetlands, NR 103 standards are applied and the WDNR makes a determination on whether the proposed activity will comply with these standards. The factors that must be considered are:

- Is the project wetland dependent? Does the project require location in a wetland to fulfill its basic purpose?
- Are there any feasible alternatives to siting the project within the wetland which would result in less adverse environmental effects? Such alternatives may include relocating the project to an upland site, even if the project proponent does not currently own a site. This is referred to as the "practicable alternatives analysis."
- What are the cumulative impacts of the project to the individual wetland, to the watershed or to other wetlands in the area?
- What are the secondary (or indirect) impacts that may be expected as a result of the project?
- Is the activity located in wetlands adjacent to, with a direct hydrologic connection to, or within an area of special natural resource interest?
- Will the activity have significant adverse effects on wetland functional values, water quality, or have other significant adverse environmental effects?

An activity does not comply with NR 103 if it is not water dependent and a feasible alternative exists, provided the alternative does not harm a wetland or have other significant adverse environmental effects. If the WDNR determines the proposed activity will have a significant adverse effect on wetland functional values, water quality or other significant adverse environmental effects, then NR 103 standards are not met and water quality certification is denied. Water quality certification is granted for projects that do not have a feasible alternative and do not have significant adverse effects.

Results of NR 103 Implementation

After the adoption of wetland standards in NR 103, the permitted wetland loss under the federal program declined from 1,440 acres per year to 347 acres per year. This indicates the regulatory control of wetland loss has been greatly strengthened by the adoption and implementation of NR 103.

Enforcement Issues

There are some indications that, at least in some areas of the state, unauthorized wetland filling is increasing, and compliance with permit conditions is lacking due to inadequate enforcement. WDNR field compliance monitoring of permitted activities in 21 counties in 1995 revealed that 31% of permitted projects are not constructed in accordance with permit conditions. From 1991 to the present, WDNR has referred 172 wetland fill violations to the U.S. Army Corps of Engineers (COE). Only five of those referrals were forwarded from the COE to U.S. EPA for enforcement action. No known action has taken place on 123 (72%) of the referrals. The COE obtained voluntary restoration for four referrals, U.S. EPA has completed enforcement action on 27 referrals, and four were resolved by WDNR.

Several factors have been identified as barriers to effective enforcement of the wetland fill permitting program including lack of direct state enforcement for water quality certifications, lack of an efficient referral mechanism and lack of sufficient resources at state and federal levels. WDNR, U.S. EPA and the COE are in the process of developing a better process and a greater commitment to enforcement.

Revisions to NR 103

NR 103 was revised in May 1998. WDNR established an advisory committee that would simplify the rule for the regulated public while at the same time protects wetlands. The result is a number of minor modifications to the rule that are summarized below:

- **Small wetland impacts –** For wetland impacts of less than a tenth of an acre, WDNR will review the practicable alternative analysis at the same time that they review the wetland functional assessment.
- **Artificial wetlands –** Created wetlands that had no prior wetland or stream history (active sewage lagoons, cooling ponds, waste disposal pits, fish rearing ponds, landscape metallic mining wetlands) are exempt from NR 103 if they have not accrued any significant habitat functions or human use values.
- **Landfill expansions –** The practicable alternatives analysis may be limited to areas adjacent to, or on the same property as, the landfill's proposed expansion.
- **Cranberry operations –** WDNR will review the practicable alternative's analysis at the same time that they review the wetland functional assessment.
- **Cranberry operations expansions** - The practicable alternative's analysis is limited to areas adjacent to, or on the same property as, the cranberry operation proposed to be expanded.
- **Wetland delineations –** Wetland delineations are based upon the procedures in the Wisconsin Department of Administration publication, "Basic Guide to Wisconsin's Wetlands and Their Boundaries," which is based on the "Corps of Engineers Wetlands Delineation Manual." The WDNR may also rely upon wetland boundary determinations made by other agencies and consultants.

Compensatory Mitigation

Compensatory mitigation can be required by the COE as a condition of Section 404 of the Clean Water Act for wetland loss that is unavoidable. The Wisconsin Department of Transportation (WDOT) has completed restoration and enhancement efforts on wetlands and created new wetlands to fulfill mitigation obligations. WDNR and WDOT have a formal process that includes a policy of compensatory mitigation for unavoidable wetland losses resulting from transportation activities. Technical guidelines call for WDOT to select an on-site location near the project first before a pre-established bank site. From 1990-98, 674 WDOT projects resulted in 1,496 acres of wetland loss. As mitigation, 68.7% of WDOT project wetland losses were compensated at bank sites, while 14.8 % were compensated on-site and 16.5% were compensated on-site but in the project vicinity.

WDOT is the sponsor of a statewide mitigation bank that includes several wetland bank sites established throughout the state. As of January 1999, the WDOT wetland bank had 30 bank sites. Nineteen bank sites are open, containing 705 available acres. There are five closed sites totaling 222 acres. Six bank sites were either in the design phase or under construction in 1999. In Wisconsin there is currently one private mitigation bank and one county-owned bank in business.

Use Classification for Wetlands

Water quality criteria are established by the WDNR to protect wetlands from chemical contaminants.

Wetland uses are established as part of Wisconsin's water quality standards. Numeric water quality criteria are established for surface waters in NR 102 and NR 105, Wisconsin Administrative Code. These criteria are used to determine wastewater discharge limitations. Historically, wetlands have been classified as limited aquatic life in NR 104 because they typically do not support a diverse fishery. However, since the adoption of NR 103, wetlands have received additional protection from wastewater discharges. Narrative criteria in NR 103 protect wetlands from chemical contaminants, physical alterations and hydrologic modifications. As part of the current efforts to update NR 104, the WDNR is reviewing the use classification for wetlands, which should afford greater protection for these waters in the future.

Protection Efforts

Local planning efforts have reduced wetland losses. Areawide water quality management plans have identified areas, including wetlands that are unsuitable for sewered development. Including wetlands in these plans provides protection to them by encouraging developers to consider upland alternatives.

Many counties are actively engaged in revising shoreland protection ordinances, which include zoning protection for wetlands. For example, Door County has recently completed a comprehensive study of all the options (both regulatory and non-regulatory) for protecting wetlands "Developing an efficient and effective wetland protection program in Door County."

Acquisition and Preservation Efforts

Many thousands of acres of wetlands have been acquired and preserved for their ecological value, wildlife habitat and recreational uses by state and federal agencies, private non-profit conservation organizations and Native American tribes. Some notable large wetland areas that are preserved for these values are the Horicon Marsh Wildlife Refuge (federal and state ownership), Crex Meadows Wildlife Area, Necedah National Wildlife Refuge, Green Bay West Shores Wildlife Area, the Upper Mississippi National Wildlife Refuge, the Mink River Estuary and the Kakagon Sloughs on the Bad River Indian Reservation.

Restoration and Enhancement Programs

There are several programs actively engaged in protecting, restoring and managing wetlands on private lands including the Wetland Reserve Program, the Conservation Reserve Program, Partners for Fish & Wildlife and the Wildlife Habitat Incentive Program. The efforts of state, federal and tribal agencies are supplemented and aided by private non-profit conservation organizations such as Ducks Unlimited, the Wisconsin Waterfowl Association, Pheasants Forever, Madison Audubon Society and The Nature Conservancy. This activity is primarily coordinated under the North American Waterfowl Management Plan. The goal of the plan is to restore continental waterfowl populations to 1970s levels. From 1991-98, approximately 51,525 acres of wetland and 154,575 acres of associated upland habitat have been acquired, restored and managed for waterfowl habitat. The plan's current goal is to have 123,713 acres of wetland and 371,137 acres of associated upland habitat secured by 2012.

Groundwater

Noted for the amount and variety of its surface waters, Wisconsin also has a vast reservoir of water underground—two quadrilion gallons of it. That's enough water to cover the entire state to a depth of 30 feet. Groundwater is used by 70 percent of the state for drinking water and is used for a variety of commercial, industrial and agricultural purposes. Groundwater also supplies fresh water to 2,444 trout streams, 5,002 warm water streams, 15,057 lakes, and 5,331,392 wetland acres in the state.

Natural Groundwater Quality

Natural groundwater quality varies greatly in Wisconsin, depending on the rocks and minerals with which the water has been, or is in contact. Minerals existing naturally in soils and rocks dissolve in groundwater, giving it a particular taste, odor or color. Radium, radon gas, uranium, arsenic, barium, fluoride, lead, zinc, iron, manganese and sulfur are undesirable constituents found in Wisconsin groundwaters.

Recent sampling has detected radionuclides in north central Wisconsin groundwater. Gross alpha activity and radium have also been found in water supplies in eastern Wisconsin. Arsenic occurs in groundwater in most of the state. It has been detected in high concentrations in 23 Wisconsin counties. About 100 municipal systems and 200 other wells could be affected by a proposed change in the federal Maximum Contaminant Level (MCL) for arsenic from 50 to 5 micrograms per liter (ug/L).

Effect of Land Use on Groundwater Quality

Land use significantly effects groundwater quality and quantity. Urban areas require large quantities of groundwater to serve many people. Activities in urban areas that pose threats to groundwater quality include industrial and municipal waste disposal, road salting and the storage of petroleum and other hazardous materials. In rural areas, less groundwater is used and there are different threats to groundwater quality. Animal waste, septic systems, fertilizers and pesticides are the primary pollution sources in rural areas. The following paragraphs describe groundwater contamination from human activities.

Nitrate

Nitrate+nitrogen (nitrate) is the most commonly detected pollutant in Wisconsin's groundwater. Statewide, ten percent of wells sampled have nitrate levels greater than the federal drinking water standard and state groundwater standard of 10 milligrams per liter (mg/L). About 90% of the nitrate leached to groundwater are from agricultural sources—either manure or commercial fertilizer. Nine percent can be attributed to septic systems and 1% comes from other sources (Shaw, 1992).

The consumption of water containing high concentrations of nitrate can induce methemoglobnemia, or "blue baby syndrome," a condition in infants younger than six months in which the hemoglobin in blood oxidizes to a form that cannot carry oxygen to the body's tissues. In extreme cases it can cause death. While methemoglobenemia is a serious condition when it occurs, the number of cases treated prior to hospitalization has not been documented and is thought to be low.

Several investigators have studied the chronic health and reproductive impacts of nitrate contaminated drinking water. Recent studies have implicated nitrate exposure as a possible risk factor associated with lymphoma, gastric cancer, hypertension, thyroid disorder and birth defects. In addition, a recent investigation conducted by local public health officials in La Grange County, Indiana implicated nitrate-contaminated drinking water as the possible cause of several miscarriages.

Pesticides

Pesticides (insecticides, herbicides, and fungicides) have been used in Wisconsin agriculture for a long time. They can reach groundwater when spilled at storage, mixing and loading sites, or when over-applied to fields. Wisconsin has identified more than 200 farm and commercial pesticide mixing and loading sites with soil contamination due to improper handling practices. Of these sites, many have been identified as having groundwater contamination as well. The state recommends soil monitoring at commercial agricultural application business sites.

Due to the frequency and concentration of atrazine in state groundwater, state rules restrict atrazine application and prohibit its use in areas where atrazine has been found to exceed the enforcement standard. The Department of Agriculture, Trade and Consumer Protection (DATCP) conducted the Atrazine Rule Evaluation Survey to determine how levels of atrazine and its metabolites in groundwater were changing three and five years after the atrazine rule was put into place. The survey was conducted in two phases: phase one in 1994 and phase two in 1996. The average atrazine plus metabolite concentration in wells with detection declined by 44% between 1994 and 1996. The percent of contaminated wells, however, did not show a significant decline.

In 1985, DATCP began a study to determine if normal field application and use of pesticides and fertilizer was causing groundwater contamination problems. Currently, 26 monitoring sites are sampled annually for nitrate and common corn herbicides in the central sands and Wisconsin River Valley—two areas vulnerable to groundwater contamination. In 1998, 85% of these sites exceeded the enforcement standard for nitrate. Atrazine and alachlor Ethane Sulfonic Acid were detected at levels exceeding their respective enforcement standard and interim health advisory levels at 10% and 12% of the sites tested.

Volatile Organic Compounds

Volatile organic compounds (VOCs) such as components of gasoline and household cleaners, are common non-agricultural groundwater contaminants. Eighty different VOCs have been found in Wisconsin drinking water supply wells according to sample analytical data stored in WDNR databases. VOCs can enter groundwater from landfills and leaking underground storage tanks such as gasoline tanks, then disperse quickly, often spreading over large distances in relatively uniform concentrations. Many older landfills have problems with leachate leaking into groundwater.

WDNR staff currently track more than 17,000 Leaking Underground Storage Tanks (LUST) sites, approximately 4,000 waste disposal facilities, and approximately 1,400 high priority Environmental Repair sites. Many of these sites have been identified as sources of VOCs to groundwater. Facilities include: gas stations, bulk petroleum and pipeline facilities, plating, dry cleaning, industrial facilities, and abandoned non-approved unlicensed landfills.

Increasing numbers of residential developments have been located close to old, closed landfills. Several of these landfills are impacting groundwater. The WDNR responded to this issue by sampling private wells located close to 15 closed landfills. Of 66 samples analyzed, VOCs were detected in 30 wells. To address this problem, WDNR staff is working closely with developers, realtors, planners and potential homeowners and improving database information on active and inactive landfill locations.

Groundwater Quantity

In 1997, the WDNR published a report describing groundwater quantity problems and issues in Wisconsin. The report, entitled "Status of Groundwater Quantity in Wisconsin," stated that despite an abundance of groundwater in the state, there is a growing concern about the overall availability of good quality groundwater for municipal, industrial, agricultural and domestic use and for adequate baseflow to our lakes, streams and wetlands.

Human activities such as groundwater withdrawal and land use activities may cause groundwater quantity problems. The effects of groundwater withdrawals are well documented on a regional scale in the Lower Fox River Valley, southeastern Wisconsin and Dane County. There are substantial declines in groundwater levels in these three areas.

Localized effects from groundwater withdrawals are not as well documented as the regional effects. Cases exist around the state where wells, springs and wetlands have gone dry; lake levels have dropped; stream flow has been reduced and contamination has prevented installation of new wells.

The availability of groundwater may also be effected by groundwater quality. The presence of naturally occurring substance in groundwater or human-caused contamination has limited groundwater use in some areas.

There is an ongoing effort by state and federal agencies and university staff to gather data and information on groundwater quantity issues. The Wisconsin Geological and Natural History Survey and the U.S. Geological Survey maintain a statewide groundwater-level observation network to evaluate short-term changes and long-term trends in groundwater levels.

Groundwater Management in Wisconsin

There are a number of agencies in Wisconsin, which have groundwater protection responsibilities. The WDNR is responsible for protecting and cleaning up groundwater and insuring that environmental standards are met. The WDNR regulatory programs are the responsibility of four Bureaus:

- The Bureau of Drinking Water and Groundwater regulates public water systems and private drinking water supply wells. The Groundwater Section assists in coordinating groundwater activities of the WDNR, as well as other state agencies. The Groundwater Section is also responsible for adoption of groundwater standards contained in Chapter NR 140, Wis. Adm. Code as well as coordinating the Wellhead and Source Water Protection programs.
- The Bureau of Waste Management regulates and monitors groundwater at proposed active and inactive solid waste facilities and landfills.
- The Bureau of Remediation and Redevelopment oversees cleanup actions at spills, abandoned containers, state-funded responses, closed wastewater and solid waste facilities, hazardous waste corrective action and generator closures, and sediment cleanup actions.

Monitoring wells are valuable in assessing if groundwater standards are being met.

- The Bureau of Watershed Management regulates Wisconsin Pollutant Discharge Elimination System (WPDES) permittees at wastewater land disposal sites. The Bureau of Watershed Management cooperates with the Bureau of Remediation and Redevelopment at leaking underground storage tanks, Environmental Response and Repair and Superfund Cleanup sites, by issuing WPDES permits for the discharge of contaminated groundwater.

DATCP is responsible for regulating most aspects of agrichemical application storage and cleanup in Wisconsin. Field staff regularly inspects storage and mixing facilities to insure they comply with groundwater regulations. If a spill does occur, money and staff are available to help with cleanup. The Nutrient Management Program helps prevent groundwater pollution by providing funding to counties to help farmers write nutrient management plans. The Agricultural Clean Sweep program provided funding to counties for collection and disposal of farm chemicals.

The Department of Commerce is responsible for tracking underground storage tanks and providing cleanup funds for tanks that have leaked to groundwater. Commerce also regulates septic systems and provides grant money for brownfield site assessment and cleanup.

The following paragraphs describe some of the efforts to address the groundwater quality and quantity issues raised above.

Through Wisconsin's groundwater protection law enacted in 1984, the state: 1) established numerical groundwater quality standards, a groundwater monitoring program, and a well compensation program for contaminated private wells; 2) created an environmental repair fund to clean up contaminated groundwater; and 3) established a laboratory certification program. The Groundwater Coordination Council was created to coordinate nonregulatory programs and the exchange of groundwater information.

In 1993, the Wisconsin Legislature enacted the Land Recycling Law, Wisconsin Act 453, to encourage the redevelopment of urban, contaminated properties, often called "brownfield sites". The Brownfields program turns property once deemed too contaminated for development back into productive lands, creating jobs, and slowing sprawl by preserving "green" areas outside of cites. In September 1995, the WDNR created the Remediation and Redevelopment (R&R) Program, to bring under one umbrella, agency staff that was responding for environmental contamination. The R&R program includes: state funded cleanups, spills and abandoned container responses, some leaking underground storage tank sites, brownfield redevelopment, federal Superfund sites, closed landfill sites causing contamination and hazardous waste closures and corrective actions.

On November 16, 1994, U.S. EPA endorsed Wisconsin's Comprehensive Groundwater Protection Plan (CSGWPP), making Wisconsin one of the first states to have an approved program in place. CSGWPP allows for better coordination of federal, state, tribal and local groundwater protection programs. Consistent with CSGWPP, Wisconsin developed an integrated, inter-agency approach for the protection of groundwater from pesticide contamination. This approach, described in the Generic State Management Plan for the Protection of Groundwater from Pesticides, was developed in cooperation with the Department of Agriculture, Trade, and Consumer Protection. It establishes the state's approach for protecting groundwater, sets out a management structure and establishes state policies on pesticide use. It establishes a procedure for any pesticide detected in groundwater, provides guidance for determining if a problem exists and how the pesticide entered the groundwater and sets up a procedure for elimination of the pesticide's use in the affected area.

The 1996 Amendments to the Safe Drinking Water Act (SDWA) require states to have a Source Water Assessment Program (SWAP) that has been approved by the U.S. EPA. The main reason for implementing a SWAP is to protect public health by preventing contamination of public water supplies. Other benefits include: avoiding the expense of cleaning up contaminated water supplies and finding alternative sources of water; reducing system costs by providing the information needed to apply for a waiver from specific monitoring requirements; and encouraging economic growth by assuring an abundant supply of clean water.

Wisconsin's SWAP was developed by the WDNR with input from numerous stakeholders to assure that drinking water concerns were addressed.

U.S. EPA approved Wisconsin's SWAP plan in November 1999. The SWAP will provide source water area delineations, potential contaminant source inventories, and susceptibility determinations for all public water systems, and provide the results of the assessments to the public. For groundwater systems, the SWAP will provide information necessary to assist the state's wellhead protection program. Follow-up wellhead protection efforts will focus on working with communities that have not yet completed wellhead protection plans.

For surface water systems, Wisconsin's SWAP utilizes the Great Lakes Assessment Protocol developed with other Great Lakes states for the 15 systems on Lakes Michigan and Superior. A different assessment methodology is provided for the four systems on Lake Winnebago and the system on Rainbow Lake that rely on surface water for their drinking water. Source water assessments will provide information necessary for subsequent watershed protection efforts in basins, sub-basins, and critical assessment areas.

Groundwater Management Coordinating Council

Under Section 160.50, Wisconsin Statutes, the Groundwater Coordinating Council (GCC) is directed to "serve as a means of increasing the efficiency and facilitating the effective functioning of state agencies in activities related to groundwater management. The GCC shall advise and assist state agencies in the coordination of non-regulatory programs and the exchange of information related to groundwater, including, but not limited to agency budgets for groundwater programs, groundwater monitoring, data management, public information and education, laboratory analysis and facilities, research activities and appropriation and allocation of state funds for research."

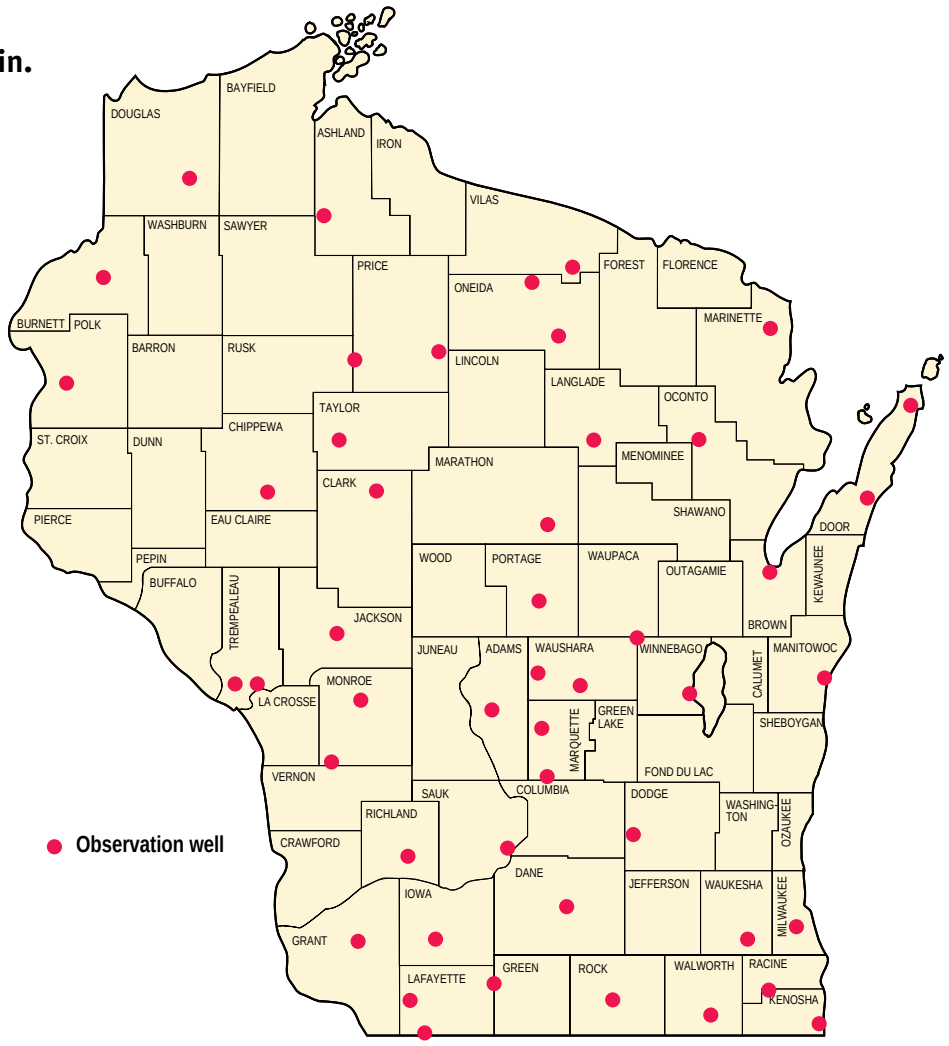
Since 1984, the GCC has served as a model for interagency coordination and cooperation among state officials, the governor, local governments and the federal government. The GCC consists of the heads of all state agencies with some responsibility for groundwater management plus a Governor's representative. The state agencies include the WDNR, the Departments of Transportation and Commerce, the University of Wisconsin, and the Wisconsin Geological and Natural History Survey. The agency heads have appointed high-level administrators who have groundwater responsibilities to sit on the GCC.

The GCC is required by section 15.347, Wisconsin Statutes, to prepare a report which "summarizes the operations and activities of the council, describes the state of the groundwater resource and its management, and sets forth the recommendations of the Council. The annual report shall include a description of the current groundwater quality of the state, an assessment of the groundwater management program, information on implementation of Chapter 160m, Wisconsin Statutes, and a list and description of current and anticipated groundwater problems." The WDNR has one permanent position with half-time responsibilities that is involved in coordination of the GCC.

Groundwater Observation Network

The groundwater observation network includes water levels measured in approximately 140 wells throughout Wisconsin. The network is part of a comprehensive and ongoing effort to maintain a water resource database responsive to the needs of the state and the nation. This program has been in place since 1946 and continues through the efforts of the USGS staff and an extensive network of observers. Approximately 20 wells are measured daily with electronic recorders. The remainder is measured on a weekly, monthly or quarterly basis by staff or observers. Figure 30 shows the location of the observation wells in Wisconsin.

Figure 30. Location of observation wells in Wisconsin.



Indicators

U.S. EPA suggests that the states report indicators that can be used to assess the long-term trends in the quality of groundwater. While indicators are important, there are some caveats. Most of the groundwater quality data available for evaluating the condition of the resource is gathered from community drinking water wells designed to prevent or minimize well contamination. These wells are placed in areas least likely to be affected by spills and runoff. Sample results may not accurately reflect average drinking water quality. Groundwater quality can also vary vertically and horizontally within an aquifer, as well as over time. Indirect indications can be seen in changes in pesticide usage, landfill design and the cleanup and removal of underground storage tanks. Changes associated with these indicators lead to elimination of potential groundwater pollution threats or improvement of site conditions, decreasing the potential of contaminant migration.

Conclusion

Wisconsin is blessed with an abundance of clean water. Given the miles of streams and rivers, the number of lakes and wetlands, the miles of Great Lakes shoreline, and the quantity of groundwater in the state, it is indeed a daunting task to assess, monitor and manage all these water resources. Despite these enormous challenges, Wisconsin citizens have been good stewards in protecting and managing the waters of the state. Reorganization of the WDNR has shifted the focus to integrated management of our land and water resources for each of the 32 river basins, and in the process, has forged new partnerships at the local levels to help monitor and protect Wisconsin's waters. These changes in structure and process will help ensure a bright future for Wisconsin's aquatic resources.